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Editorial

Dear IEJEE Readers,

It's a great pleasure for me to present Vol. 11, issue 2 of International Electronic Journal of Elementary Education for our valuable readers.

IEJEE has been eleven years old. During the past ten years, IEJEE did enormous contribution to our educational research world. We'll continue to do the same in this new year as well.

In this issue, thirteen articles addressing different educational issues.

I want to thank all the contributors and IEJEE's hard working editorial team and all the peer reviewers.

I wish you all a happy new year.

Editor-In-Chief

Prof. Dr. Kamil Özerk,
Editor-In-Chief, IEJEE

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Effect of "Understand and Solve!" Strategy Instruction on Mathematical Problem Solving of Students with Mild Intellectual Disabilities

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Abstract

The purpose of this study was to examine the effects of "Understand and Solve!" Strategy on change problems including change of a one-step addition and subtraction of children with mild intellectual disabilities and whether they maintained their achievements 3, 5, and 8 weeks after the intervention. Moreover, the effects of the Understand and Solve! Strategy on generalization to different types of problems and multiple step problems as well as on the perception, attitudes, knowledge, use, and control of problem solving strategy were investigated. Three students with intellectual disabilities who were 11 to 12 years old and attended 5th grade participated in the study. "A Multiple Probe Design Across Subjects," which is one of the single subject research designs, was used in the study. The findings of this study showed that Understand and Solve! Strategy was effective in teaching students with mild intellectual disabilities solving change problems including one-step addition and subtraction, they maintained their skills and generalized their skills to different problem types, two-step change problems. As a result of the intervention, students' perception and attitudes towards mathematics as well as knowledge, use and control of strategies to solve mathematical problems positively changed.

Keywords: Cognitive Strategy Instruction, Self-Regulation Strategies, Problem Solving, Mild Intellecutal Disabilities

Introduction

Problem solving, which is one of the principal achievements during elementary school years, constitutes an important place in every stage of life during both school years and after. Problem solving is a comprehensive process in itself while it consists of calculation, prediction, and thinking (The National Council of Teachers of Mathematics [NCTM], 2000). Solving a mathematical problem is defined as a complex cognitive activity which involves several processes and strategies (Montague, 2000). During this activity, cognitive and metacognitive processes and strategies are used (Montague, 2008; Montague & Dietz, 2009; Özsoy & Ataman, 2009). Cognitive processes used in problem solving are comprehension, translating, transforming, planning, predicting, calculating, and evaluation (Montague, 1992). However, cognitive strategies include strategies beginning from reading the problem to controlling the process such as a) reading, b) describing in own words, c) predicting, d) visualizing the problem on a paper or visualizing it by mental imaging, e) developing hypotheses, f) calculating, and g) controlling (Montague, 1992; Montague & Bos, 1986). Metacognitive processes focus on the awareness of the cognitive knowledge that manages and organizes the cognitive processes that are needed for problem solving. This awareness includes strategy knowledge and use and strategy control (Montague, 1992). The metacognitive strategies i.e., self-regulation that provides for strategy organization and awareness used in problem solving involve self-instruction, self-question, and self-monitoring (Montague, 1992; 2007; 2008).

Students with mild intellectual disabilities have issues in the achievement of the problem solving skills which constitute a challenging and complex process (Geary, 1994; Özsoy, Kuruyer & Çakıroğlu, 2015). Most of these students have problems in identifying important information in the problem and transforming verbal and numerical information into operations (Montague, 1997). In addition, students with mild intellectual disabilities usually have limitations in the use of cognitive and metacognitive strategies (Geary, Brown, & Samaranayake, 1991). Therefore, while teaching these students how to solve mathematical problems, not only procedural steps but also the necessary cognitive and metacognitive strategies to follow these steps are also taught.

The primary approaches that try to teach problem solving by instructing problem solving strategies to children are process based approaches. In process based approaches, in general, the teacher models the process to the student by thinking aloud the steps in order to teach the necessary cognitive and metacognitive strategy use during the problem solving process (Montague, 2008). The purpose with it is to have the students internalize the strategy by allowing interactional dialogs and procedural facilatators (Güzel-Özmen, 2006).

The Cognitive Strategy Instruction, which contains the elements of cognitive and metacognitive strategy teaching in mathematical problem solving and is a process based approach, was used with both *students with learning disabilities* (Cassel & Reid, 1996; Daniel, 2003; Iseman & Naglieri, 2011; Krawec et al., 2012 ; Krawec, 2014 ; Maccini & Gagnon, 2001; Maccini & Hugles, 2000; Mancl, 2011; Montague & Bos 1986; Montague & Dietz, 2009; Montague, 1992; Montague, 2008; Montague et al., 2011; Naglieri & Das, 1997; Naglieri & Gottling, 1995; Naglieri & Johnson, 2000; Rosenzweig, Krawec, & Montague, 2011; Swanson, Orosco, & Lussier, 2014) and *mild intellectual disabilities* (Chung & Tam, 2005; Cote, Pierce, Higgins, Miller, Tandy, & Sparks, 2010; Huffman, Fletcher, Grupe, & Bray, 2004; Keogh, Whitman, & Maxwell, 1988; Van Luit & Van der Aalsvoort, 1985); and it was found to be effective. Montague and Dietz (2009) evaluated the studies which tested the effectiveness of cognitive strategy instruction in solving mathematical problems. The analysis showed that cognitive strategy instruction could not be defined as an

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evidence-based practice in teaching solving mathematical problems. Authors suggested that there is a need for more experimental evidence. This result shows that the number of research studies in which criteria of evidence-based practices are implemented must be increased. Some studies have been conducted since 2009 that show that cognitive strategy instruction was effective for students with intellectual disabilities and learning disabilities (Cote et al., 2010; Krawec et al., 2012; Krawec, 2014; Montague, Enders, & Dietz, 2011; Swanson et al., 2014; Swanson, Lussier, & Orosco, 2013). A Cognitive Strategy Instruction Model namely "Solve It! Strategy," which involves cognitive and metacognitive elements, was developed Montague (1992) and it is one of the process based teaching strategies. Solve It! is a strategy which aims to teach seven cognitive strategy steps (i.e., read, paraphrase, visualize, hypothesize, predict, calculate, and check) and in each of the cognitive strategy step it contains three metacognitive steps (ask, say, and check). This strategy was used to teach solving word problems to *middle school students with learning disabilities* (Daniel, 2003; Krawec, Huang, Montague, Kressler, & Alba, 2012; Montague,1992), Spina Bifida (Mesler, 2004), and it was found to be effective. Chung and Tam (2005) also found that Solve It! Strategy, of which strategy steps were modified, was effective in teaching mathematical problem solving skills to middle school *students with mild intellectual disabilities.*

Another process based approach in problem solving is the Self-Regulated Strategy Development (SRSD) (Case, Harris, & Graham, 1992). The process aims to develop metacognitive strategies that are needed to solve the problems. This approach targets teaching some self-regulation strategies (such as self-instruction, self-monitoring, self-reinforcement) and students are expected to self-regulate during the problem solving process. SRSD teaching which aims to teach strategy steps and self-regulation strategies used in problem solving includes a) developing and activating background knowledge, b) discussing the strategy, c) modeling of the strategy, d) memorizing the strategy, e) supporting the strategy, and f) independent performance. In order for the students to move from one stage to another the student has to meet the criteria for remembering and implementing the strategy. Therefore, SRSD is a criterion-based implementation (Case et al., 1992). Case et al. (1992), accelerated the process of student's learning the strategies and independent use of these strategies in solving mathematical problems by modifying Self Regulated Strategy Development approach.

A review of the studies conducted in the literature showed that there is only one study which aimed to teach students with intellectual disabilities solving mathematical problems in Turkey (Karabulut, Yıkmış, Özak, & Karabulut, 2015). In that study the effects of schema-based instruction on the mathematical word-problem-solving performance of students with intellectual disabilities were examined. Since students with intellectual disabilities have problems in using cognitive strategies (Chung & Tam, 2005) and self-regulation (Cassel & Reid, 1996) during solving mathematical problems, and thus they utilize explicit and sequence step presentation, there is also a need to test the effects of multi-element cognitive strategy teaching modified for the characteristics of students with intellectual disabilities.

Therefore, the purpose of this study was to examine the effects of Understand and Solve! Strategy, which was designed to utilize Modified Solve It! Strategy and include self-regulation strategies such as self-instruction and self-monitoring during the strategy steps, on solving change problems including a one-step addition and subtraction for students with mild intellectual disabilities.

Method

Subjects

Three students with mild intellectual disabilities who were first graders of special education classrooms in middle schools participated in this study. The inclusion criteria for the subjects were that a) they had 80% accuracy in additions with involving regrouping in addition and subtraction (Case et al., 1992), b) the rate of accuracy was at least two, at most four, out of 10 operations including change of a one-step addition and subtraction. Out of five students who met these criteria three were randomly chosen as study subjects.

The first student was 12 years and 3 months old girl who was a middle school first grader with 70 IQ score and mild intellectual disability. She was able to accurately solve nine out of 10 additions with regrouping and eight out of 10 subtractions with regrouping. She correctly solved three out of 10 problems including change of a one-step addition and subtraction. She had no additional disabilities.

The second student was 11 years and 9 months old boy who was a middle school first grader with 69 IQ score and mild intellectual disability. He was able to accurately solve 10 out of 10 additions with regrouping and nine out of 10 subtractions with regrouping. He correctly solved four out of 10 problems including change of a one-step addition and subtraction. He had no additional disabilities.

The third subject was 11 years and 8 months old girl who was a middle school first grader with 67 IQ score and mild intellectual disability. She was able to accurately solve nine out of 10 additions with regrouping and nine out of 10 subtractions with regrouping. She correctly solved four out of 10 problems including change of a one-step addition and subtraction. She had no additional disabilities. All three subjects were attending special education classrooms.

Setting

The study sessions were conducted in a 7m x 5m dimensions, empty classroom which was designed as an art studio. A video recorder was placed in the room to record the sessions for inter observer reliability and procedural fidelity.

Dependent and Independent Variables

The dependent variables of the study were the number of correctly solved change problems including a one-step addition and subtraction; knowledge, use, and control of mathematical problem solving strategy; attitudes towards mathematics; and attitudes towards solving mathematical problems. The independent variable was Understand and Solve! Strategy.

Research Design

In this study a multiple probe design across subjects was used to identify the effects of Understand and Solve! Strategy skills of students with mild intellectual disabilities regarding change problem including a one-step addition and subtraction.

While the multiple probe design across subjects was implemented in the study, one probe was conducted with each of the three subjects separately on the same day in order to assess the performance of students regarding change problem solving. With the first subject that the intervention would be initiated, three separate sessions of baseline level data were collected. When the first subject's problem solving performance showed consistency, with the first subject Understand and Solve! Strategy was initiated to teach solving problems. As in the baseline, three consecutive probe sessions were conducted following intervention (post-instruction). When the first subject reached the criterion of 90% or more rate of accuracy with stable data patterns, with the second subject three consecutive sessions were conducted to assess the baseline of the performance related to solving mathematical problems. At the same time, one probe session was conducted with the third subject. The same process was implemented likewise until the independent variable was implemented with all three subjects. In order to assess the sustainability of the skill achievements post-intervention; 3, 5, and 8 weeks following the intervention one time follow-up data were collected with each of the subjects. Moreover, generalization data were gathered in the baseline, post-instruction, and follow-up in order to identify the generalization performance of the subjects on one-step categorization and comparison problems, and two step change problems.

Development of Understand and Solve! Strategy

The steps of Understand and Solve! Strategy was developed utilizing the Modified Solve It! Strategy. Firstly, cognitive strategy steps of Solve It! were modified. The students are asked to draw a picture or a diagram related to the problem in the "visualize the problem" step, which is one of the steps of Solve It! cognitive strategy steps. However, in this study the students were asked to choose an appropriate schema related to the problem and they were asked to place the problems into the schema. Secondly, self-regulating strategy approach was adopted as the instructional method (Case et al., 1992). All the steps included developing and activating background knowledge, discussing the strategy, modeling of the strategy, memorizing the strategy, supporting the strategy, and independent performance. (Case et al., 1992; Reid & Lienemann, 2006). In this study, It was aimed that; a) development of all prerequisite skills required from the students in order to use the strategy and b) explicitly helping students to teach them how to use the strategy by using this steps; As a result, students are able to learn all the process which is important in understanding and solving the problems as well as organizing the problem solving process and achieving more general metacognitive strategies regarding evaluation (Case et al., 1992). Thirdly, as a feature of SRSD approach, two of the self-regulation strategies namely self-instruction (identification of the problem, directing attention and planning, strategy, self-assessment and error correction, coping with the issues and self-control, self-reinforcement) and self-monitoring were used. Lastly, procedural facilatators used in the cognitive strategy instruction were included to make the students internalize the self-instruction and teach the strategy (Doğanay-Bilgi, 2009; Englert, Raphael, & Anderson, 1992; Güzel-Özmen, 2006; Güzel-Özmen, 2011).

Understand and Solve! Strategy Instructional Stages

For each of the instructional stages of the Understand and Solve! Strategy (Read the problem and tell, underline the keywords, draw the schema of the problem, make a plan and solve the problem, control it), an instructional plan and procedural facilatators were prepared by utilizing the previous sources (Casse et al., 1992; Chung & Tam, 2005; Montague, 2000; Montague, 1992; Reid & Lienemann, 2006).

Strategy steps which can be seen in Table 1 are presented in five stages.

Developing and activating background knowledge. In order for the student to implement the Understand and Solve! Strategy keywords (remains, left, decreased, spent, etc.) that could lead the child in solving the problem were taught (Case et al., 1992). Since the performance regarding the operation was set as a prerequisite, during the stage of enacting prior knowledge, operations were not performed. This stage continued until the students learned the keywords which would lead them in the problem solving (Case et al., 1992).

Discussing the Strategy. In this stage, the benefits of using the strategy were explained. The steps of the strategy were introduced, what can be done on each step and which of the procedural facilatators could be utilized were

Table 1. *Understand and Solve! Strategy steps*

1. Read the Problem and Tell!	The purpose is that the student read the problem and then tell it in her or his own words to solve it. Sample self-instruction statements are as follows "I can understand if I read carefully, I will read it once and if I don't understand I will read again, I can understand the problem better if I look at my problem worksheet"
2. Underline the Keywords!	After reading and telling the problem, the purpose here is to facilitate the determination of the operation by identifying the keywords which constitute the problem by underlying the words which cause mathematical change in the problem. Sample self-instruction statements are "I will identify the important words, I will read the problem carefully and if I don't understand it I will read it again"
3. Draw the Schema of the Problem!	The purpose here is to make the problem be easily understood by visualizing what is known and what is required. Sample self-instruction statements are "I will write all the things I know on the related place of the schema, then I will find what is required of me"
4. Make a Plan and Solve the Problem!	The purpose is to identify and write down which operation to be used and what steps to follow in order to reach the desired outcome starting from what is known. Sample self-instruction statements are "this is the most important part, I need to be careful, I know what is asked of me, I will find the necessary operation"
5. Check!	The purpose is to control all the steps that the student has gone through starting from reading the problem until calculation. Sample self-instruction statements are "I need to control all the steps"

explained (Milford & Harrison, 2010; Reid & Lienemann, 2006). The student and the researcher discussed why and how each of the strategy step would be used in one step addition and subtraction problems as well as what we could think as we use the strategy and the importance of what we might think were discussed. While introducing the steps of the strategy, Understand and Solve! Strategy Monitoring Checklist was used. This list consists of two columns. On the first column, the titles of the strategy steps and symbolic pictures to make the strategy steps easily remembered were used; on the second column there is an empty space for the students to check after they complete each step.

Modeling of the Strategy. In this stage, all of the steps of the Understand and Solve! Strategy are implemented by using procedural facilatators and Strategy Monitoring Checklist by thinking aloud. How to implement the strategies of self-regulation which includes self-instruction and self-monitoring are modeled through thinking aloud. In this session, models were presented for four problems. In this study, Memorizing the Strategy, which is one of the instructional stages of the self-regulation approach, was not included, instead in order for the students to make transitions from modeling to guided practice, it was planned that the students repeated the strategy steps, used self-instruction and self-monitoring through all the steps. How and why to use each of the procedural facilatators in each step of the problem solving strategy was modeled through thinking aloud.

During the modeling stage Understand and Solve! Strategy Monitoring Checklist was used to support the student by checking each step s/he completes while solving the problem making her/him able to identify the step s/he is at. In addition, in this stage for Read the Problem! Step, to facilitate understanding of the problem, the Problem Reading Sheet was used. This sheet consisted of three columns. On the first column there are questions to facilitate the understanding of the problem. On the second column there is a space for the student to write her/his answers. On the third one s/he can check the questions that s/he cannot answer.

During the "Draw the schema of the problem to make it easier!" stage, a "Change Problem Schema" was used to facilitate the drawing of the schema related to the problems including change. This schema includes three separate clusters to write down the amount of beginning, change and ending. In the "Plan and solve the problem!" step, a Planning Sheet was used that would facilitate which operation to be used in the problem solving and which steps could be taken in what order. This sheet is a procedural facilatator that was prepared for the student to write down the process prior to problem solving in order. In the "Do the calculation!" step of the strategy a Problem Solving Sheet, which is an empty paper, was used to perform the calculations. Lastly, at the last step of the strategy which is "Check it!" the "I Monitor Myself Checklist" was used to enable the student check whether s/he has implemented necessary strategies for the problem. This list is a procedural facilatator which consists of two columns, one with questions prepared for the student to check the things s/he has to do at every stage and the other one with space to put a mark.

Supporting the strategy. In this stage, when the student became more experienced and self-confident in using the strategy the procedural facilatators were faded. In each of the guided practice sessions, students were guided through solving four problems. Guided practice continued until the student became independent in using the strategy and used the self-instruction statements correctly in the right place.

Independent Practice. In this stage the students were encouraged to solve the one-step addition and subtraction problems using the strategy independently. In the independent practice stage when the students met the criteria of answering nine out of 10 problems correctly this stage was terminated, and post-intervention assessment was conducted.

Preparation of Target Problems

In this study four types of problems were used: in the assessment and instructional sessions change problems including a one-step addition and subtraction, in the generalization one-step categorization and comparison problems, and two step change problems. The problems were prepared similar to the problems in the elementary school books included by Ministry of National Education and they consisted of problems including change, categorization, and comparison.

For preparation of the problems a total of 240 one-step change problems (80 problems in each of the categories including unknown starting amount, change amount, and outcome amount), 120 one-step categorization problems (60 problems in each of the categories including unknown total amount and unknown amount for a part), 120 one-step comparison problems (40 problems in each of the categories including unknown amount of difference, comparison, objects or concepts), 10 two-step change problems (60 problems in each of the categories including unknown starting amount and outcome amount). Problems were written with 12-point Comic Sans MS characters, 1.5 line spacing on an A4 paper. All the problems prepared were used in the research process. In Table 2 the number and type of problems used in each experimental stage are included.

Data Collection Instruments

In order to measure the dependent variables of this research Problem Solving Record Chart, Mathematical Prob-

Table 2. *The number and type of problems used in each experimental stage*

Type of Problems	Baseline	Generalization to Classroom Performance Baseline	Post-Intervention	Generalization to Classroom Performance Post-Intervention	Generalization of Strategy Performance to Classroom Post-Intervention	Follow-up
One-step change problems	50	10	30	10	10	30
One-step categorization problems	30		10			30
One-step comparison problems	30		10			30
Two-step change problems	30		10			30

lem Solving Assessment Form, Strategy Observation Form, and Social Validity Questionnaire were used. In the following section information related to data collection tools and the data collection process are explained.

Problem Solving Record Chart. In order to determine the number of correctly solved problems, a chart was prepared for recoding the answer of each problem. On top of the chart the personal information and date are written and under that there is a chart to record the answers given to 10 problems. The number of correct answers were calculated by recording the answers of students on this chart.

Strategy observation form. Ten questions were provided to the students in the classroom environment and strategy observation form was used to examine the generalization of the strategies that the students used in solving change problems including one-step addition or subtraction to the classroom environment. In this form cognitive strategies involved in Understand and Solve! Strategy were included. Students were observed in the classroom and whether they used the strategies or not were recorded. In addition, answers of the students were recorded on the Problem Solving Record Chart to identify their correct answers.

Mathematical problem solving assessing short form (MPSA-SF). Mathematical Problem Solving Assessing Short Form (MPSA-SF) was developed by Montague (1992). It is an informal diagnostic instrument to identify the strong and weak sides of the students in solving mathematical problems (Montague, 1992). In the form there is a part that contains information related to the student. The form includes a total of 40 items in two parts. The first part of the form includes 10 questions, five of them are open-ended and other five are 5-point Likert-type statements to identify the students' mathematical perception, attitudes towards mathematics, and attitudes towards problem solving. The second part of the form contains 30 open-ended questions that were prepared to identify the problem solving strategy knowledge, use, and control. For reading strategies, the questions 11-17, for interpretation 18-21, for visualization 22-25, for hypothesis 26-29, for prediction 30-33, for calculation 34-36, for checking 37-39, and to identify mathematical problem solving strategy knowledge 40th question were asked. The permission was requested from the author and it was translated into Turkish. For the language validity of the MPSA-SF in this study, one language expert and six academicians from the special education field who had excellent command of English were consulted. In the direction of the experts' opinions necessary changes were made and it was translated back into English, the items on the original form and items on the adapted and back translated new form were compared and their similarities were then examined followed by necessary changes providing language equivalence.

Social validity questionnaire. In order to examine the opinions of students and teachers regarding Understand and Solve! Strategy, a Social Validity Questionnaire was developed. It was prepared to identify the opinions of students regarding the program content and outcomes as well as the teachers' opinions about the development of the students who participated in this study. This questionnaire for the students consists of 10 items which can be rated on a 3-point Likert scale (never-always). The questionnaire for the teachers includes 10 items which can be rated on a 5-point Likert scale (Never-Rarely-Sometimes-Generally-Always).

Experimental Procedures

In this study experimental procedure was implemented in five stages as the baseline, instruction, post-instruction assessment, generalization, and follow-up. Before the experimental stages, a 12 session pilot study was conducted with a student with intellectual disabilities who had the prerequisite skills until the student acquired the problem solving skills. During the pilot study, an observer monitored the sessions and the problems recognized by the observer and the researcher were corrected and then then experimental procedure was initiated. The experimental process was implemented by the first researcher. The researcher is an expert in special education field and he has publications and presentations regarding teaching mathematics to students with intellectual disabilities.

During the experimental process, one-to-one sessions were held with each student every day of the week at the predetermined times. With each subject the sessions were conducted at the first lesson. The study lasted five months. Baseline. In the baseline, the subjects' performance on one-step addition and subtraction change problems and generalization problems was identified. Students were given a worksheet containing 10 mathematical problems and they were asked to solve these problems. In each session same type but different problems were provided to the students and at least three consecutive sessions of baseline level were conducted to identify the initial level of the performance. Generalization baseline was conducted one time for the first student, two times for the second and three times for the third student. In addition, before the instruction by MPSA-SF student's performance was identified.

Implementation of "Understand and Solve! Strategy". When the baseline data were stable, Understand and Solve! Strategy was implemented. In the study, every session was conducted every day until the instruction was over. Sessions were planned to be 30 minutes with 10 minutes break. During the instruction of Understand and Solve! Strategy the number and duration of each instruction stage conducted for each of the subjects are given in Table 3.

Post instruction assessment. Having completed the implementation, post-instruction assessment was conducted for three consecutive sessions likewise the collection of baseline data. When one student's accuracy was 90%

Table 3. *Number and duration of sessions implemented with each subject during Understand and Solve! Strategy instruction*

	1st Subject		2nd Subject		3rd Subject	
Instruction Sessions	# of Sessions	Duration	# of Sessions	Duration	# of Sessions	Duration
Developing and activating background knowledge	2	60	2	60	2	60
Discussion	2	60	2	60	2	60
Modeling	5	105	4	100	5	130
Supporting the strategy	2	90	2	60	2	60
Independent Practice	2	60	2	60	2	60
Total	13	375	12	340	13	370

or more at the end of the instruction and the data were stable, post-instruction assessment was terminated and baseline data were gathered from other subjects. At the end of the instruction, performance of the students was examined by MPSA-SF. Generalization post-instruction assessment was conducted likewise in the baseline as a single session following generalization instruction.

In order to examine the generalization of the students' strategy use to the classroom environment, 10 one-step change problems were given to the students and their use of the strategy then was observed.

Generalization instruction. How to solve the one-step categorization problems including addition and subtraction as well as comparison problems, and two-step change problems including with addition and/or subtraction were modeled once using Understand and Solve! Strategy.

Follow-up. Follow-up data were collected in order to examine whether students still maintained their achievements of solving change problems including a one-step addition and subtraction 3, 5, and 8 weeks after the post-instruction assessment of Understand and Solve! Strategy. Generalization follow-up data related to problems of different type and including multiple steps were collected 3, 4, and 5 weeks after.

Implementation of social validity questionnaires. Following post-intervention assessment, social validity questionnaires were filled by students and teachers.

Data Collection and Scoring

In this study five types of data were collected as the effectiveness, follow-up and generalization, data gathered from MPSA-SF, and social validity. In the following section data collection and scoring are explained.

Data collection and scoring related to effectiveness, follow-up, and generalization and scoring. Assessments were conducted to identify the correctly solved problems in the baseline, post-instruction, and follow-up phases. Before starting assessments, the following statement was provided to the student "We will solve some mathematical problems" After the researcher told the student as "Are you ready to solve the problems?" and received the answer of "I am ready" the researcher put one worksheet in front of the student and he put another in front of himself and provided instruction as "Read the problems carefully and solve them" The researcher thanked the student when s/he finished the worksheet and worksheets were then removed. The researcher recorded how many problems the student answered correctly, incorrectly or s/he left blank on the problem solving record chart. The correctly solved problems were scored as 1 point. The problems with correct solutions were accepted as correct, the ones that were incorrect or left blank were accepted as incorrect. In order to examine the generalization of the strategies into the classroom, strategies that the students used solving the problems on the worksheet in their classrooms during their mathematics lessons were recorded on the Strategy Observation Form. The number of each strategy the students used for these 10 problems on the worksheet were calculated and scored on Strategy Observation Form.

Implementation of MPSA-SF and scoring. MPSA-SF was conducted face to face with the student. At the beginning, the student was provided the following statements "There are three mathematical problems here. I will read them to you. You need to solve them." And the researcher read all the problems and asked the student to listen them carefully. These problems included change, categorization, and comparison with addition or subtraction. The first problem included a one-step change problem that required the outcome amount, the second included a one-step change problem that required the change amount, and the last one included a one-step change problem that required the starting amount. Later the student was told "I want you to answer the questions I will ask you, when you are ready, we can start, I will write down your answers." When the student said "I am ready" first 10 questions were verbally presented. On the first part, in order to identify the student's perception of the mathematics the questions 1-3, attitudes towards the mathematics the questions 3-7, and knowledge of mathematical problem solving strategies questions 8-10 were asked by the researcher.

On the second part, the student was provided the problems that the researcher read to her/him and with the instruction of "solve the problems" the assessment was initiated. The researcher told the student "If you have difficulty in reading or understanding the words you can ask my help. When you finish solving the problem let me know." The student was provided one problem at a time and when s/he finished all the problems s/he was handed the problems for her/him to check the problems. The student was expected to solve the problems in 10-12 minutes, if s/he could not solve the problem the researcher then said "Ok, I will ask you other questions" and the problem was put away. Later the researcher asked the open ended questions on MPSA-SF starting from the 11th question. Answers to each question was noted under the related question. As previously indicated, on MPSA-SF there are questions to identify reading strategy (questions 11-17), interpretation (questions 18-21), visualization (questions 22-25), prediction (questions 30-33), calculation (questions 34-36), checking (questions 37-39), and to identify mathematical problem solving strategy knowledge there was the 40th question. All the assessment process was video recorded.

For mathematical perception, attitudes towards mathematics and problem solving, the first five questions were scored as 1 to 5 (bad to very good). The answers to one-step problems including change, categorization, and comparison were noted as correct-incorrect. Answers given by the students to the open-ended questions regarding problem solving strategy knowledge, use, and control (6-40) were analyzed. The answers were scored 0 to 5 (never=0, very little=1, a little=2, average=3, good=4, and very good=5).

Social validity data collection. Before conducting the social validity questionnaire to the students, to make students become familiarized with such questionnaires since they had not any experience with such tools, a similar questionnaire was administered with them about a subject that the students had experience. After this, social validity questionnaire was given to the student and s/he was asked to read the items and answer them one by one, s/he was assured to ask if there was anything she/he did not understand. The teachers were provided with the questionnaire and they were asked to answer the questions.

Data Analysis

Two types of graphics were used for data analysis. Problem solving performance of the students and MPSA-SF data (Montague, 1992) were shown in line graphics. The baseline data and pretest data were compared to the post-instruction data. The increase in the data having implemented the independent variable compared to the baseline level indicates the effect of the strategy. Generalization data of students' use of strategies in the classroom were also shown in line graphics. Generalization of problem solving performance to the classroom environment was shown in a bar chart. Answers to the social validity questionnaire were descriptively analyzed and the results were interpreted accordingly.

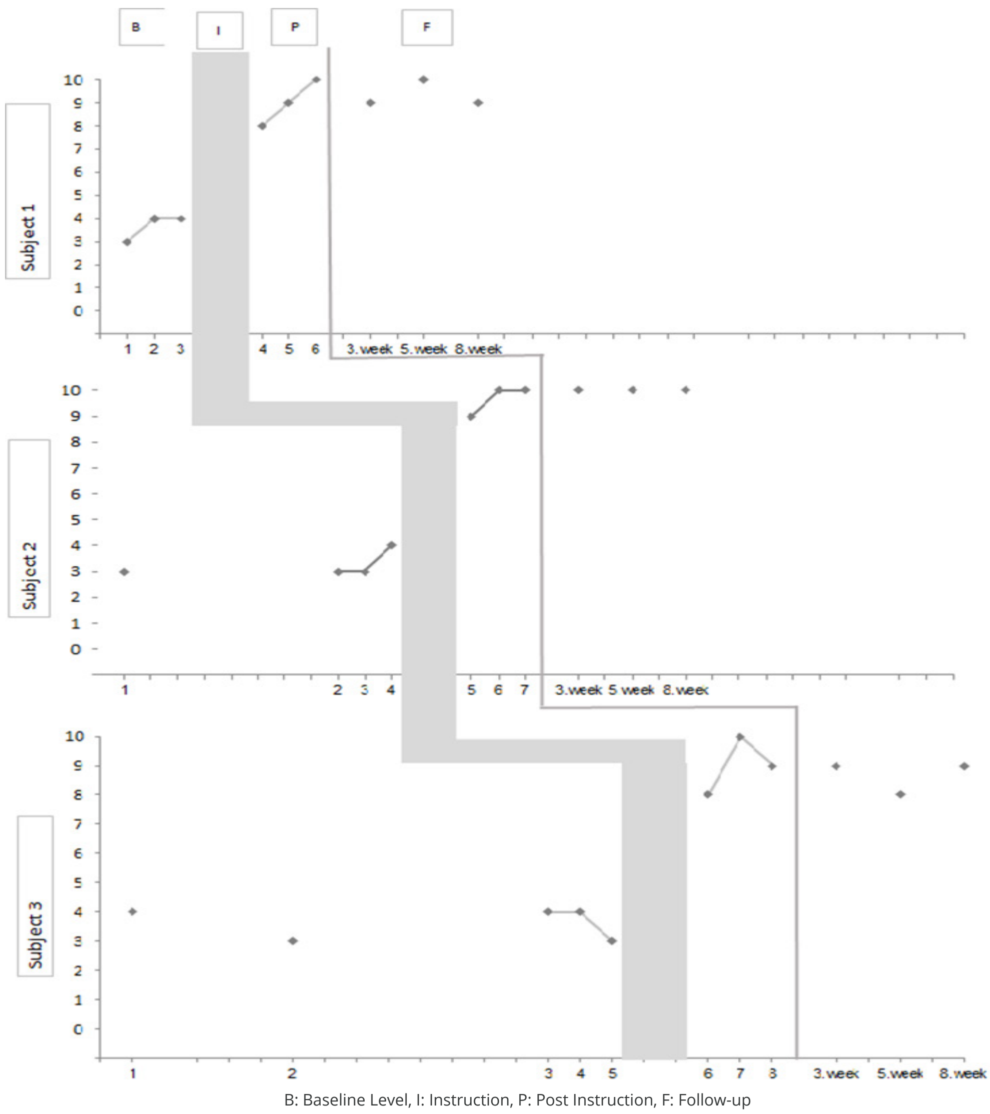
Procedural fidelity. Procedural fidelity was assessed at the beginning and end of the experimental process. With the first student an observer was present at the beginning of the experimental process and she observed both the assessment and intervention sessions. The observer had a master’s degree in special education field. She was informed about how to use the observer fidelity forms. She was seated at a quiet place in the room where she could see the implementation and would not draw attention of the student. During this process, procedural fidelity quotient was calculated for both assessment and intervention sessions, and when the quotient was 90% or more for at least three successive sessions, the observation process was terminated. The same process was conducted at the end of the experimental process for implementation and assessment sessions as well. Both for assessment and intervention sessions, samples were selected from each student and procedural fidelity was calculated for at least 30% of the sessions. Procedural fidelity for this research study was 100% for assessment and 95.65% for the instruction (range between 95.25% - 96%).
Interobserver agreement. In this study, from each of the student sample sessions were chosen including all assessment sessions (baseline, post-instruction assessment, generalization, and follow-up) of problem solving variable and for 32% of the research data interobserver agreement was calculated. The observer had a master’s degree in special education field. The observer was provided the student’s problem solving sheets and she was asked to identify the number of correct answers related to the addition and subtraction problems. For all the subjects the interobserver agreement was 100%.

To provide reliability of the answers given to the open-ended questions of the MPSA-SF, the researcher and an expert from the field of special education scored the answers. Interrater reliability for the first, second, and third subject was 90, 92, and 90, respectively.

Results

Baseline, post-instruction, and follow-up data related to solving change problems including one-step addition and subtraction are given in Graphic 1.
As it can be seen in Graphic 1, the level of data path obtained at the end of the Understand and Solve! Strategy is higher than the baseline. All three subjects met the criteria of 90% at post-instruction. In addition, follow-up sessions showed that there was not any decrease in the data compared to the post-instruction.

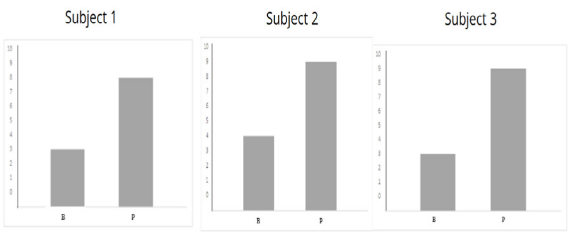
Generalization of subjects’ performance related to solving change problems including one-step addition and sub-



B: Baseline Level, I: Instruction, P: Post Instruction, F: Follow-up

Graphic 1. Baseline, post-instruction, and follow-up results related to students’ solving change problems including one-step addition and subtraction.

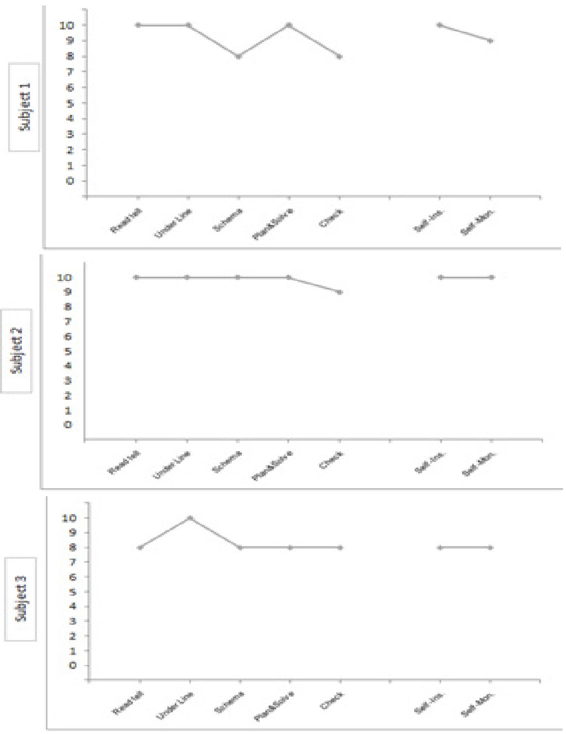
traction into classroom environment regarding pre- and post-instruction are given in Graphic 2.



B: Baseline Level, P: Post-instruction

Graphic 2. Generalization of subjects' performance related to solving change problems including one-step addition and subtraction into classroom environment regarding pre- and post-instruction

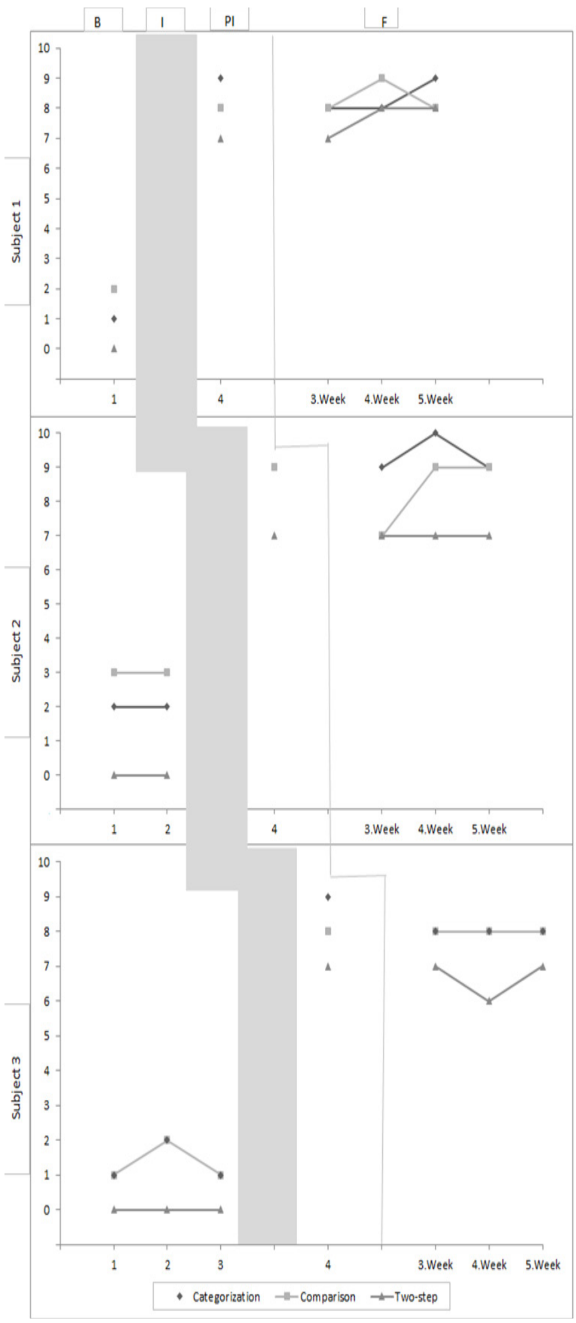
All subjects generalized their problem solving performance to their classrooms after the Understand and Solve! Strategy instruction. During solving 10 problems the subjects exhibited "read and tell the problem" strategy 9 times on average, "underline the keywords" strategy 10 times on average, "draw the schema of the problem" strategy 9 times on average, "make a plan and solve the problem" strategy 9 times on average, and "control all steps" strategy 8 times on average. Self-instruction, which is a self-regulation strategy, was seen in 9 out of 10 problems on average, self-monitoring during the strategy steps was seen in 9 out of 10 problems on average. Generalization of subjects' solving change problems including one-step addition and subtraction are given in Graphic 3.



Graphic 3. Generalization of subjects' use of strategies into their classrooms

As it can be seen in Graphic 3, all three subjects generalized strategies to solve change problems including one-step addition and subtraction as well as self-regulation strategies to the classroom.

Baseline, post-instruction, and follow-up data of subjects' generalization of one-step categorization and comparison problems and two-step change problems including addition and subtraction are given in Graphic 4.



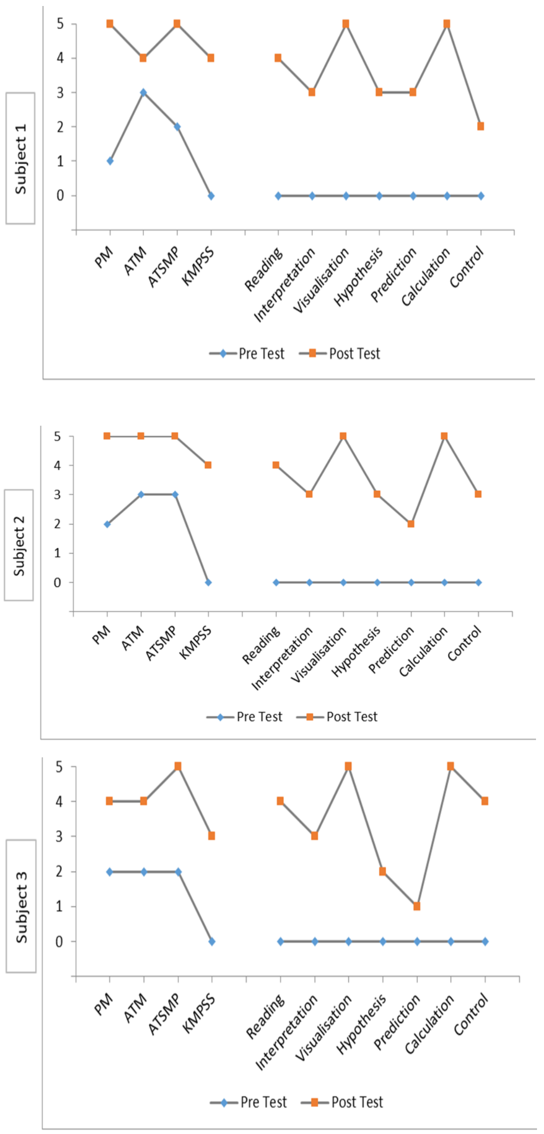
B: Baseline, I: Instruction, P: Post Instruction, F: Follow-up

Graphic 4. The number of correct answers of the subjects to one-step categorization and comparison, and two-step change problems

As it can be seen in the Graphic 4, when the baseline level and post-instruction data level were compared, it was seen that for all three subjects the difference in the level was higher than the baseline level. The subjects reached 80% to 90% accuracy in one-step categorization problems at the end of the instruction. In addition, in the subsequent follow-up sessions, the first and second subject's number of correctly solved problems did not change. Only the accuracy of the third subject decreased one point.

For comparison problems, the subjects showed 80% to 90% accuracy. In addition, at the post-instruction their number of correctly solved problems did not change in the follow-up. For two-step change problems including addition and subtraction, the subjects had 70% accuracy at the post-instruction. Moreover, in the follow-up the number of correctly solved problems increased one point for the first subject and remained the same for the second and third subjects.

Subjects' pre- and post-test findings related to their perceptions about mathematics, attitudes towards mathematics and solving mathematical problems; knowledge, use, and control of problem solving strategy which were assessed by the 5-point Likert-type MPSA-SF questions are given in Graphic 5.



MP: Perception of Mathematics, ATM: Attitudes towards Mathematics, ATSMP: Attitudes towards Solving Mathematical Problems, KMPSS: Knowledge of Mathematical Problem Solving Strategy

Graphic 5. Subjects' data related to their perceptions about mathematics, attitudes towards mathematics and solving mathematical problems; knowledge, use, and control of problem solving strategy which were obtained by the MPSA-SF

When the subjects' pre- and post-instruction scores are compared it can be seen that their scores on all of the variables in MPSA-SF increased. Attitudes towards mathematics (1 point on average) and prediction (2 points on average) increased less than other strategies. Knowledge of solving mathematical problems strategy (3 points on average), visualization (5 points on average), and calculation (5 points on average) increased more.

Social Validity Results

Table 4 includes the responses of the students to the items of social validity questionnaire.

Table 4. *Responses of students to the social validity questionnaire*

Items	Never	Sometimes	Always
1. Understand and Solve! Strategy helps me solve mathematical problems.			3
2. I will use Understand and Solve! Strategy in Mathematics lessons from now on.			3
3. It was easy to use Understand and Solve! Strategy.			3
4. I had fun while learning how to use Understand and Solve! Strategy.			3
5. I really liked the worksheets we used while learning Understand and Solve! Strategy.			3
6. Understand and Solve! Strategy lessons made me learn the strategy easily.			3
7. I had so much fun while using the schemas in Understand and Solve! Strategy.			3
8. The schemas in Understand and Solve! Strategy help me a lot in solving problems.			3
9.While implementing Understand and Solve! Strategy thinking out loud helped me a lot.			3
10. I recommend my friends Understand and Solve! Strategy who have difficulties in solving mathematical problems.			3

According to the social validity questionnaire students' opinions related to the Understand and Solve! Strategy were positive.

In Table 5 responses of teachers to the social validity questionnaire are provided.

According to the social validity questionnaire it can be seen that the teachers' opinions about Understand and Solve! Strategy were positive.

Discussion

Discussion of the effectiveness findings

The findings of this study showed that Understand and Solve! Strategy was effective in teaching students with mild intellectual disabilities solving change problems including one-step addition and subtraction, they main-

Table 5. *Teachers' responses to the items on the social validity questionnaire*

Items	Never	Rarely	Sometimes	Generally	Always
1. In mathematics lessons, my student engages in the lesson more than s/he used to do before attending the study.				1	2
2. My student can correctly solve the mathematical problems I hand out during the lessons.					3
3. My student finishes the homework I give in the mathematics lessons.				3	
4. My student does the homework of mathematical problems correctly.				3	
5. My student asks for help less while solving problems.				3	
6. My student makes drawings while solving the problems to visualize the problem.				1	2
7. The time that it takes my student to solve the problems decreased.					

tained their skills and generalized their skills to different problem types, two-step change problems, and to classroom environment. These results are consistent with the findings of the studies conducted using Modified Solve It! Strategy students with learning disabilities (Daniel, 2003; Krawec, Huang, Montague, Kressler, & Alba, 2012; Montague, 1992) and intellectual disabilities (Chunk & Tam, 2005). In this study, different than Modified Solve It! Strategy, Understand and Solve! Strategy was implemented. Even though Understand and Solve! Strategy is different in terms of presentation in several steps than Modified Solve It! Strategy, these strategies have common strategy steps. In their study, Chung and Tam (2005) found that Modified Solve It! Strategy was effective on the performance of problem solving of students with intellectual disabilities and maintaining this performance 2 weeks after the instruction. They linked this to modifying Solve It! Strategy as well as the fact that students with intellectual disabilities learned the cognitive and metacognitive strategies. In the current study, the observations conducted in the classrooms showed that students were able to implement all the strategies. At the end of the instruction, the students carefully read the problem, underlined the keywords, expressed the problem in their own words, drew an appropriate schema, planned the problem solution, predicted what would be the outcome, performed the calculation, and checked the outcome. In this regard, it might be suggested that the reason why the Understand and Solve! Strategy was effective was that the characteristics of the presentation of the strategy were adapted to fit the characteristics of the students with intellectual disabilities as well as the students learned the strategy steps. In addition, as a common characteristic of cognitive strategy instruction, Understand and Solve! Strategy implemented the following steps respectively: read and tell, underline the keywords, draw a schema of the problem, make a plan and solve the problem, control it. Implementing these steps in a holistic way might have played a role in using cognitive strategies and processes which take place in students' problem solving process, thus yielding accurately solving the problem (Montague, 1992). It is thought that presenting Understand and Solve! Strategy with self-regulation approach might have contributed to the positive results on effectiveness, maintenance, and generalization of students' skills. Understand and Solve! Strategy has the components of "self-instruction" and "self-monitoring through strategy steps" which are metacognitive strategies. Individuals need self-talk to manage, organize, and construct their cognitive functions to help prepare appropriate action plans and better understand the problems (Case et al., 1992). With self-instruction this self-talk is improved. This self-talk is not used to communicate with others, rather it is used to manage, organize, and construct cognitive functions (Case et al., 1992). Self-instruction statements ensure the understanding of the students about how to implement the strategy, develop effective and efficient strategies, and use these strategies in problem solving to monitor and to maneuver (Case et al., 1992; Cassel & Reid, 1996). In the current study, the students started using statements while solving problems to identify the necessary strategies, remind oneself which strategy or skill to use in a certain step, self-reinforce, and to control the steps. With these observations in mind it could be suggested that students developed self-talk during the problem solving. Therefore, self-instruction is thought to have a great role in obtaining effective results related to problem solving. In the current study, self-monitoring, which is one of the metacognitive strategies for self-regulation, was utilized. Self-monitoring helps students follow the strategy steps accurately and completely and follow the certain tasks at specific steps while solving problems, thus yielding self-control (Montague, 2007). In this study, self-monitoring was used during the implementation of respective strategy steps. Self-monitoring might have helped the students easily monitor whether they implemented the strategy steps used in the problem solving or not and learn the strategy steps as well as it might have helped to contribute to the self-control, and self-assessment.

Other characteristics of Understand and Solve! Strategy include the following: arrangement of the strategy instruction according to the SRSD teaching steps, setting a criterion for transition to the next step in instruction, internalization of the self-instruction for the students, and including procedural facilatators used in cognitive strategy teaching to make students learn the strategy. As indicated in the literature, during the stages of "Modeling, Guided Practice, and Independent Practice" the teacher needs to model the strategy steps and gradually fade the guidance and require the student independently implement the strategy and thus setting criterion for these stages might contribute to the independence in implementation (Case et al., 1992; Cassel & Reid, 1006; Graham & Harris, 2003). The accuracy of the students' answers to the problems during the teaching of Understand and Solve! Strategy was in direct proportion to the accurately use of strategy steps. When the subjects implemented the strategy steps accurately and fully their performance increased more rapidly. When a subject forgot one or more of the strategy steps they could not solve the problem correctly. It is stated in the literature that the strategy teaching must be explicit (Case et al., 1992; Cassel & Reid, 1996; Doğanay-Bilgi, 2009; Graham & Harris, 2003, pp.323-324; Güzel-Özmen, 2006; Güzel-Özmen, 2011; Krawec et al., 2012; Montague & Dietz, 2009; Swanson et al., 2014). It is thought that presenting Understand and Solve! Strategy according to the SRSD stages might have led the students with mild intellectual disabilities implement these steps as well as learn, maintain, and generalize the strategy.

The results of the studies in which cognitive strategy was instructed showed that student with various disabilities generalized their problem solving skills to different types of problems and different settings (Case et al., 1992; Chung & Tam, 2005; Cote et al., 2010; Daniel, 2003; Huffman, Fletcher, Grupe, & Bray, 2004; Iseman & Naglieri, 2011; Keogh, Whitman, & Maxwell, 1988; Maccini & Gagnon, 2001; Maccini & Hugles, 2000; Mancl, 2011; Montague & Dietz, 2009; Montague, 1992; Montague, 2008; Naglieri & Das, 1997; Naglieri & Gottling, 1995; Naglieri & Johnson, 2000; Rosenzweig et al., 2011;Van Luit & Van der Aalsvoort, 1985). In the current study, Understand and Solve! Strategy teaching also increased the students' generalization performance. In their study of examining the effectiveness of Understand and Solve! Strategy to students with intellectual disabilities Cassel and Reid (1996) investigated the generalization of skills to classroom environment and they suggested teaching generalization to students with intellectual disabilities. In the current study, the researcher modeled only once to show the students how to use the strategy in generalization problems and for students to learn the problem structure. With only one session of generalization instruction to show how to implement Understand and Solve! Strategy with different type of problems was sufficient for the subjects to generalize the strategy. The reason for that could be that during the instruction of Understand and Solve! Strategy the implementer does not only teach solving change problems. In the foundation of teaching cognitive strategies lies the teaching the strategy rather than the targeted skills. When the students learned the strategy, they became aware of the skill structure thus they were able to generalize the strategy to different types of problems even to problems that were more difficult such as the two-step problems.

In the follow-up and generalization performance of the subjects, both increased metacognitive experiences and more internalized cognitive strategies might have played a role. A common characteristic of cognitive strategy teaching is that the strategy steps are implemented by thinking out loud and interactive dialogs take place during the implementation, thus leading the student internalize the strategy (Özmen, 2017). During this study, the students were observed to be extensively using thinking out loud in the guided practice, independent practice, and post-instruction assessment process that they were not observed to be used during the baseline. This kind of thinking process might show that they started to internalize the strategy. In addition, the subjects indicated that they really liked to use the strategy as they used self-regulation statements such as "I know what to do to solve the problem, the problem solving has become fun, because I already solved such problems before." These statements show that their metacognitive experiences increased. When the metacognitive experiences increase strategy generalization performance also increases (Efklides, 2001; 2006; Efklides & Petkaki, 2005).

Discussion of MPSA-SF Findings

At the end of the intervention, students' scores on MPSA-SF increased and students' knowledge, use, and control of solving mathematical problems improved. These findings are consistent with the findings of research studies implementing Solve It! Strategy (Montague, 2008; 2007; 1992).

When the pre-test and post-test scores were compared, it was seen that the smallest change was for attitudes towards mathematics, but the greatest change was for the knowledge of strategy for solving the mathematical problems. The reason for the less change in the attitudes towards mathematics might be that prior to the study the students' problem solving strategy knowledge was insufficient or they were using insufficient strategies. Accordingly, students did not get any points from this measure before the instruction. For the strategy knowledge; self-instruction and self-questioning are needed and for strategy control self-monitoring strategies need to be implemented (Montague, 2008; 2007; 1992). There was an increase in the post-test scores of strategy knowledge of the students with mild intellectual disabilities that might have been due to self-instruction, self-monitoring, and presentation of strategy steps during the modeling, guided practice, and independent practice stages of Understand and Solve! Strategy. However, this increase is less than the findings reported in the previous research studies (Daniel, 2003; Krawec et al., 2012; Montague, 1992; Sweeney, 2010). This difference might be due to the fact that MPSA-SF's questions about the strategy knowledge and control do not overlap with the strategy knowledge given in Understand and Solve! Strategy. In the Understand and Solve! Strategy the prediction step did not take place. Therefore, the scores of students about prediction and control were low. Mathematical problem solving strategy use and control. When the students' use and control of mathematical problem solving strategy were examined it was seen that there were improvements in all of the strategies, however, the highest improvements were in visualization and calculation (5 points), and the lowest improvements were in hypothesis development and prediction (1 point to 3 points). There are previous studies in which findings showed that the increase in the post-test scores of mathematical problem solving strategy use and control compared to the pre-test scores were higher than the findings in this study (Daniel, 2003; Krawec et al., 2012; Mesler, 2004; Montague, 1992; Montague & Dietz, 2009; Whitby, 2009). In those studies, Solve It! Strategy was used. Since the MPSA-SF overlaps with the strategy steps included in Solve It! Strategy, it might provide an explanation for the reason why the increase in the scores in the previous studies were higher. Similar to the findings of the current study, results in terms of the strategy use and control, in studies in which Solve It! Strategy was modified, the scores of the students were higher than the studies in which this strategy was not modified (Chung & Tam, 2005; Daniel, 2003; Krawec et al., 2012; Mesler, 2004; Montague, 1992). Therefore, the difference between the pre- and post-test results might be due to adaptation in the strategy and that the assessment tool did not overlap with the strategy steps.

Perceptions about Mathematical Performance. At the pre-test before the instruction students' scores related to the perceptions about their mathematical performance were at least 1 to at most 2 out of 5, whereas at the post-test after the instruction their scores were at least 4 to at most 5 out of 5. These findings related to the perceptions about mathematical performance are consistent with the findings of previous studies in which MSPA-SF was implemented during strategy instruction. At the end of the instruction, scores related to the perceptions of mathematical performance were higher for students with learning disabilities (Daniel, 2003; Krawec et al., 2012; Montague, 1992; Sweeney, 2010), learning disabilities and intellectual disabilities (Montague & Dietz, 2009), Autism and Asperger's syndrome (Whitby, 2009) as well as Spina Bfida (Mesler, 2004). These results show that teaching cognitive strategies in problem solving might improve the perceptions of students about the mathematical performance. Moreover, self-instruction, self-questioning, self-monitoring, which are metacognitive elements included in the cognitive strategy teaching, might play a role in perceptions about the mathematical performance (Montague & Applegate, 2000). Schraw (1998) indicated that optimizing the sources, better implementing the known strategies, and recognizing the problems might increase the performance. Case et al. (1992) also emphasized that when students used self-regulation strategies this positively affected the academic success. Self-instruction, which was one of the components of the Understand and Solve! Strategy used in the current study, might have role in changing perception related to mathematical performance.

Attitudes towards Mathematics. When the findings of the subjects of this study regarding attitudes towards mathematics were examined, it was seen that their scores related to their attitudes were at least 2 and at most 3 out of 5 on pre-test, whereas their scores on post-test were at least 4 and at most 5. These findings might show that the Understand and Solve!' Strategy was effective in positively changing attitudes towards solving mathematical problems of students with mild intellectual disabilities. There are studies in the literature that examined the relationship between the number of accurately solved problems plus strategy performance and attitude of students with learning disabilities, intellectual disabilities, and autism (Daniel, 2003; Krawec et al., 2012; Mesler, 2004; Montague, 1992; Montague & Dietz, 2009; Sweeney, 2010; Whitby, 2009) as well as the effects of the different type of instructional strategies on attitudes towards mathematics and solving mathematical problems (Daniel, 2003; Krawec et al., 2012; Mesler, 2004; Montague, 1992; Montague & Dietz, 2009; Sweeney, 2010; Whitby, 2009). These study results show that there is a positive relationship between the increase in the number of problems solved plus strategy experience and attitudes and different type of instructional strategies might positively affect attitudes towards mathematics and mathematical problem solving. With the implementation of Understand and Solve! Strategy, the subjects learned the problem solving process and the cognitive and metacognitive strategies necessary for problem solving and they reached the accurate results in problem solving using these strategies yielding metacognitive experiences might contribute to the development of positive attitudes in students.

Knowledge of mathematical problem solving strategies. The scores related to the knowledge of students regarding mathematical problem solving strategies was 0 out of 5 points on pre-test. After the instruction their scores were at least 3 and at most 4. This finding shows that Understanding and Solve! Strategy was effective in increasing mathematical problem solving strategy knowledge of students with intellectual disabilities. Implementation of Understand and Solve! Strategy based on SRSD stages and the criterion identified for the transition from one strategy stage to other might have led to these results. These results are similar to the results of studies in which strategy teaching was implemented with students with various disabilities using MPSA-SF (Daniel, 2003; Krawec et al., 2012; Mesler, 2004; Montague, 1992; Sweeney, 2010; Montague & Dietz, 2009; Whitby, 2009). In this study as well, similar results were obtained with students with intellectual disabilities. In this regard, the results of the study show that cognitive strategy teaching was effective on not only the skill to be taught but also the knowledge of mathematical problem solving strategy. As a consequence, the perception of the students regarding their performance, their attitudes, and strategy knowledge improved when compared to the pre-instruction.

Social validity. In this study, the results of the data gathered from the subjects and teachers showed that the opinions about the Understand and Solve! Strategy were positive. These results show that strategy teaching is positive in terms of social validity.

The limited number of studies in the literature and the results of these studies show that strategy instruction when modified for the students with intellectual disabilities is effective in making them achieve problem solving skills (Chung & Tam, 2005). There are a few number of studies in which students with intellectual disabilities were provided with strategy instruction in academic skills. In some of these studies, strategies were modified (Chung & Tam, 2005; Doğanay-Bilgi, 2009; Güzel-Özmen, 2006; Güler-Bülbül, 2016) in some other studies strategies which were effective for students with learning disabilities were implemented likewise (Alfassi, Weiss, & Lifshitz, 2009; Cote et al., 2010; Konrad, Trela, & Test, 2006; Lundberg & Reichenberg, 2013). In this regard, effectiveness of the strategies implemented in the same way with students with learning disabilities and modified strategies should be tested on students with mild intellectual disabilities. Studies like that would serve to identify effective instruction for students with mild intellectual disabilities to achieve academic skills.

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The Predictive Power of Elementary School Students' Trait Anxiety Level in Physical Education Lesson on Their Attitudes towards Lesson

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Abstract

The aim of this study is to determine the predictive power of elementary school students' trait anxiety level in physical education (PE) lesson on their attitudes towards lesson. The study group consisted of 590 elementary school students (M_{age}= 11.46 years, *SD*= 0.63). In addition to the descriptive statistics, inferential statistics were used in this research like correlation and regression analysis. At the end of the study, it was observed that course on the attitudes of trait anxiety effect size to have a low level of trait anxiety subscale attitude towards the course of the variables that make up 3% of the total variance explained in the levels. Besides, it was identified that students' attitudes towards physical education classes are high, the physical education lesson is a medium level of trait anxiety. Gender-related differences were not significant in the students' trait anxiety and attitudes towards the lesson.

Keywords: Attitudes, Anxiety, Trait Anxiety, Elementary Education, Physical Education Lesson

Introduction

Physical education lesson, to achieve the goals of education is just one of the tools used to but perhaps the most fun and is most effective when used correctly (Öztürk, 1998). Physical education in school curricula is defined as a form of development for students with physical activities, knowledge, attitudes, motor and behavioural skills for the purpose of participating fun and active life that includes physical continuity (Pate, Corbin, & Pangrazi, 1998). Physical education lesson in general, although fun course among students by many students to learn and practice may be perceived as a difficult subject. Studies such as getting pleasure from physical education classes generally positive affective experiences are also observed (Barr-Anderson, Neumark-Sztainer, Schmitz, Ward, Conway, Pratt, Baggett, Lytle, & Pate, 2008), physical education lesson is an important determinant of being experienced in the state of anxiety, achievement goals, effort, and learning strategies as well as performance and performance-related information (Cury, Da Fonséca, Rufo, Peres, & Sarrazin, 2003).

Phillips (1984) also stated that one of the important factors that affect the learning process is anxiety. Very low and high anxiety levels that make it more difficult to learn, a medium anxiety simplifies learning and encourages (Seven & Engin, 2008). Genetic and biological factors, learnings, experience and the living environment of the concern caused by the stimulus (Kutlu, 2001), were classified in two ways by Spielberger, as trait anxiety and state anxiety (Cheng & Cheung, 2005). State anxiety is the emotional response of people with special situations as threatening as a result of interpretation (Kutlu, 2001). The trait anxiety was expressed as a threat to their specific situations and against this tendency to increase the level of state anxiety (Spielberger, 1966, qtd. in Martens, Vealey, & Burton, 1990).

The field of physical education and sports in the some studies related concerns were investigated concerns for mostly students or athletes in a class of non-specific anxiety levels (Ariza-Vargas, Domínguez-Escribano, López-Bedoya, & Vernetta-Santana, 2011; Chamanabadi, Pooladiborj, Esmaeili, & Zamani, 2012; K.meswania, 2012; Selmi, Selmi, & Hermassi, 2013). In some studies, a variety of concerns related to physical education and sports activities for children and young people in reducing anxiety levels were also investigated (Dalkıran & Tuncel, 2007). However, in terms of content and teaching methods are different in other areas of education physical education lesson is especially important to live in the state of anxiety. Considering the fact that physical education lesson is predominant in physical skills and that evaluations are made in front of students' peers, situations such as students' inadequacy of their peers, failure, injury and body image concerns (Shepard & Trudeau, 2000; Tremayne, 1995) can be seen intensively. It was thought that this kind of concerns could be reflected in the students' reluctance towards physical education lesson, shyness and negative attitude.

Attitudes shape human behaviour in different ways determines participation in everyday activities and shapes behaviour of people as a condition to accept or leave. (Rikard & Banville, 2006). According to Morris, the attitude is composed of three components are known as thoughts, feelings, and behaviours. Our thoughts basic information about an object has been explained as (i.e., physical education and sports classes in terms of understanding the importance of the human health), as we like and what we feel like sense objects (i.e., physical education and sports lesson love and dislike), the behaviour that we exhibit our actions against objects (i.e., continuous participation in physical education and sports classes) (Demirhan & Altay, 2001; Morris, 2002).

School lessons in the context of attitude; represent the sum of feeling, beliefs and values of that lesson (Osborne, Simon, & Collins, 2003). In other words, to have a positive or negative thought about lesson, of a course, like and dislike and consequently is studying cognitive, including affective and behavioural characteristics (Bloom, 1995). Located in courses related to physical education lesson at each course that the student can develop a positive or negative attitude (Demir-

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han & Altay, 2001). The fact that students have positive attitudes toward PE lesson can make the lessons more effective and also it can facilitate students' achieving their specific or general aims (Silverman & Scrabis, 2004). The first objective of physical education lesson in the students develop positive attitudes and life-long physical activity contribute to raising given that is also an important factor in achieving positive attitudes about the course developed for efficient processing (Demirhan & Altay, 2001; NASPE, 1995) together with the objectives of education.

This age group of children in physical education lesson and fun activities generally look upon the game as less capable physically they are thought to be concerned for the children's classes is a condition observed. However, increasing rise in obesity among children in this age group, in children can be seen this with restricted mobility concerns over the course of development. This anxiety in students is thought to be in the case of on attitudes towards physical education lesson also cause adverse effects. Indeed, many studies examining the relationship between attitude and anxiety in students' attitudes towards students with a course for that course has been a close relationship between anxiety (Baloğlu, Koçak, & Zelhart, 2007; DeVaney, 2010; Doğan & Çoban, 2009; Finney & Schraw, 2003; Hussain, 2011; Kurbanoğlu & Takunyacı, 2012; Onwuegbuzie, 2000; Yenilmez & Özabacı, 2003). Onwuegbuzi (2000) in his study in the field of statistics has indicated that anxiety level is the determinant of a student's attitude. Finney and Schraw (2003) have found a negative relationship statistically significant correlation between anxiety and attitudes. Yenilmez and Özabaci (2003) stated that mathematics attitude is a high correlation between math anxieties, with regard to mathematics students have a positive attitude towards the course that allows being successful, and that it lowers the anxiety level. Baloglu, Kocak and Zelhart (2007) have examined the relationship between statistics anxiety with college students' attitudes towards statistics and have found that student's anxiety is high according to negative attitude towards this course. Doğan and Çoban (2009) in their study with faculty of education students, have found a negative and significant relationship in students' attitudes towards the profession and with low levels of anxiety. De Vaney (2010) in his work in the field of statistics concluded that the low anxiety level was associated with more positive attitudes. Kurbanoğlu and Takunyaci (2012) stated that self-efficacy beliefs of the students and the development of positive attitudes would reduce the level of anxiety towards mathematics. Hussain (2011) in his study found significantly negative relationship between English learning and English anxiety. Nevertheless, Bekdemir (2007) as stated that anxiety is one of the factors in the formation of negative attitudes. When individuals develop negative attitudes about any subject, they do not love it, interest is reduced and that increases failure. Attitudes affect success, success affects attitude. Negative attitudes developed due to the problems caused by the education of individuals or the environment, over time, reflected in behaviour, after a period of time form a failure cycle. In this case, with failure prejudice of individuals increases the likelihood of experiencing anxiety.

Physical education lesson for a serious problem in adolescence age with physical education lesson for the attitude (Akandere et al., 2010; Butcher & Hall, 1983; Portman, 1995; Subramaniam & Silverman, 2007) and physical activity and physical education lesson to participate in the reduction (Ntoumanis, Barkoukis, & Thogersen-Ntoumani, 2009; Sallis, Prochaska, & Taylor, 2000) of probable cause as one of the physical education lesson developed for the continuous state of anxiety and with it physical education or physical activity developed against, negative attitudes are thought to be. Thus, if students can develop positive attitudes towards in elementary school physical education and physical activity, the experienced problems considered to be avoided in adolescence. To develop positive attitudes towards physical education classes and classes that reduced levels of trait anxiety in realizing the goals of education has an important place in physical education classes and is important in order to ensure the highest level of benefits. In addition, attitudes towards physical activity at a young age that earned considering the positive attitude toward the course, especially if ensured in this period, in children of lifetime sports consciousness can contribute to the settlement.

Studies in the field of anxiety and attitudes related to physical education examined that there is no study between the relationship of anxiety and attitudes towards physical education lesson. Therefore, to determine the elementary school students' physical education lesson for the trait anxiety levels and attitudes, however, may be useful for the physical education lesson levels of trait anxiety, attitudes towards the course on the extent to be effective detection.

Method

Research Group

The research group, consisted of 590 various primary and secondary schools students selected through random sampling studying in Ankara (M_{age}= 11.46, *SD*= 0.63).

Data Collection Tools

"Physical Education Trait Anxiety Scale (PETAS)" and "Elementary Physical Education Attitude Scale (EPEAS)" were used as data collection tool.

Physical Education Trait Anxiety Scale. "Physical Education Trait Anxiety Scale" (The Physical Education Trait Anxiety Scale) was developed by Barkoukis, Rodafinos, Koido and Tsorbatzoudis (2012), and adapted to Turkish by Kalemoğlu Varol (2014). Scale as the original form was formed by 3 factors as "cognitive processes", "somatic anxiety" and "worry", and the total of 18 items. There are 6 items in each dimension. It was graded as Scale (1) strongly disagree, (5) strongly agree as 5 point Likert-type scale. All items are positive statements in the scale and higher scores represent higher levels of anxiety. Scale showed high internal consistency and test-retest reliability. Cronbach's alpha coefficients of internal consistency; was found to be .93 for the subscales of cognitive processes, for somatic anxiety sub-factor 97, for sub-factor for concern .98 and for the whole scale .94. The test-retest reliability coefficient is .96. Confirmatory factor analysis of the results obtained in the higher compliance values, showed 3 factors of verification of the structure of the scale (RMSEA= 0.064, NFI= 0.97, NNFI= 0.98, CFI= 0.99, SRMR= 0.033, GFI= 0.88 ve AGFI= 0.84).

Elementary Physical Education Attitude Scale. Elementary Physical Education Attitude Scale was developed by Phillips and Silverman (2012) and adapted to Turkish by Kalemoğlu-Varol, Erbaş, Ünlü and Sünbül (2014). The scale is composed of a total of 15 items including 7 negative, 8 positives. Scale items are grouped under the so-called "cognitive" and "affective" factors. Likert-type scale response code will be given to each item ranged from 1.00 to 5.00. Rating agents consist of "1-strongly disagree, 2-Disagree, 3-Undecided, 4-Agree, 5-Strongly Agree" options. The lowest score that can be obtained from the scale 15 and the highest score was 75, and higher scores represent higher levels of attitude. Scale showed high internal consistency and test-retest reliability. Cronbach's alpha coefficients of internal consistency; was found to be .96 for the subscales of cognitive processes, for sub-factor for concern .95 and for the whole scale .83. The test-retest reliability coefficient is .77. All of the differences between item means of supergroups and subgroups with 27% were found meaningful. Confirmatory factor analysis values obtained showed that it is 2 factors in the alignment of the scale factor structure verification (RMSEA= 0.06, CFI= 0.99, SRMR= 0.03, GFI= 0.93 and AGFI= 0.89).

Data Analysis

In the study, the distribution was examined prior to data analysis. It was found that the data was consistent with distribution by the Lilliefors and Kolmogorov-Smirnov test, Histogram graphics and normal distribution curve, and skewness and kurtosis. In the study, the arithmetic means of the items that were included in each subscale were calculated and after this calculation the score was determined for each relevant factor. The analysis was performed via these factor scores. In the analysis of data; Descriptive statistics and *t*-test for independent groups, in order to determine the relation. Also, Pearson Moments Multiplication Correlation Coefficient technique was used in order to identify the relationship. Furthermore, Multiple Linear Regression Analysis was employed with the purpose of determining the predictive power of the independent variables on the dependent variables. In these analyses, each of the PE trait anxiety scale's sub-factor scores were taken as independent variables, and the attitude towards Physical Education was accepted as the dependent variable. In the interpretation of the data, 0.01 and 0.05 significance levels were used. The data obtained in the research was analysed with SPSS 23 software.

Results

In the study group of the students' attitudes towards physical education lesson with average scores on trait anxiety levels and standard deviation values are given in Table 1.

Table 1. *Elementary school students' physical education and attitude levels of trait anxiety*

Variables	*n*	*M*	*SD*
Trait Anxiety Total	590	52.00	9.59
PE Lesson Attitude Total	590	39.95	14.36

Analyzing the Table 1; of elementary school students in physical education lesson middle of trait anxiety ($M_{anxiety}$= 39.95, *SD*= 14.36), course attitude was found to be high ($M_{attitude}$= 52.00, *SD*= 9:59).

Trait Anxiety Level and Course Attitude According to Gender

Table 2 presents the results of the analysis to determine whether the students' trait anxiety levels and the attitudes of the students differ according to gender variable.

Analyzing Table 2, physical education lesson in attitude and trait anxiety levels were not observed significant differences by gender (*p*> .05).

The relationship between trait anxiety level and the attitude towards the lesson

The relationship between trait anxiety level and attitudes toward the PE lesson was tried to be determined and analysis results were given in Table 3.

Analyzing Table 3, the cognitive subscale of the scale of physical education, trait anxiety subscale of the scale and the low level of concern a relationship was found to be negatively (*r*= -.134; *p*< .01).

It was tried to determine predictive power of trait anxiety levels on attitudes towards the lesson and results of analysis were given in Table 4.

Table 2. *Trait anxiety levels and course attitude according to gender*

Variables	Gender	*n*	*M*	*sd*	*df*	*t*	*p*
Trait Anxiety Total	Female	330	40.47	14.85	588	996	320
	Male	260	39.29	13.71			
PE Lesson Attitude Total	Female	330	54.71	9.24		.976	.631
	Male	260	54.68	10.12			

Table 3. *The relationship between trait anxiety level and course attitude*

VARIABLES	C	A	CP	SA	W
Cognitive (C)	1				
Affective (A)	.026	1			
Cognitive processes (CP)	-.003	-0.44	1		
Somatic Anxiety (SA)	.068	-0.44	.718**	1	
Worry (W)	-.134**	-0.15	.633**	.631**	1
Mean	26.40	25.60	12.98	12.66	14.30
Standart Deviations	6.80	6.59	5.16	5.35	5.81

***p< .01*

Table 4. *The prediction of the trait anxiety level on the attitude (cognitive) towards the PE lesson*

Variables	*B*	Standard Error	ß	*t*	*p*	Dual *r*	Partial *r*
Constant	24.974	.819		30.491	.000		
Cognitive Anxiety	-.243	.081	-.185	-2.989	.003*	-.003	-.123
Somatic Anxiety	.090	.078	.071	1.149	.251	.068	.047
Worry	.241	.065	.206	3.713	.000**	-.134	.152
R= 0.182		R^2= 0.033					
F= 6.690		*p*= .000					

**p< .05 **p< .01*

Analyzing the findings in Table 4, the course of trait anxiety attitude (cognitive dimension) procedure equation (*R*= .182, *p*< .01) is important. Trait anxiety level courses illustrate the attitude of 3% of the total variance. The standardized regression coefficient (ß) of the predictor variables based on the relative order of importance concerns the attitude of course, is form of cognitive processes and somatic anxiety. Conclusions regarding the significance of regression coefficients examined the lessons of the sub-dimensions of anxiety and cognitive processes to be significant predictors of attitudes, whereas somatic anxiety variable was found to be a significant variable. In line with these results, levels of trait anxiety attitude on course to have a low level of effect size were determined.

Discussion and Conclusion

In the study of elementary school students in physical education lesson at the middle level is the level of trait anxiety were identified. There is no study to support these findings directly. However, as the age group classes and many students often fun (Barr-Anderson et al., 2008) considering that look already high anxiety level is not expected. However, in the mid-level anxiety about whether a course totally fun and enjoy indicator has been received. Thus in future studies that the examination of the factors behind the anxiety score is deemed beneficial.

Another result obtained from the study of students' attitudes towards physical education classes is that positive. Similarly Trudeau and Shephard (2005) in a study conducted by high school students attitudes towards the course grade level but now they have a level that is indicated by a decrease in attitude. Subramaniam and Silverman (2007) in studies conducted with middle school students by The students' attitudes towards physical education classes were found to be medium level.

Students in physical education classes trait anxiety levels when analyzed by gender (Table 2), the physical education of trait anxiety scale total score was found to be higher than male students. There is no study to support these findings directly. However, physical activity, anxiety, and other areas of concern identified studies related to the level of research findings are examined in parallel with studies (Ginsburg & Silverman, 2000) have been found. The idea that women are more anxious than men is not a new idea. Kierkegaard (2009) also stated that women than men are concerned that, this situation women's physical weakness, not from the essentially spiritual in nature due to the fact that spirituality increases anxiety increases. Related to physical education and sports activities, girls are physically more delicate than men and have more reservations because of the structure, physical education classes to be related to high levels of trait anxiety is a condition generally expected. However, research findings large number of non-overlapping of work, considering the constant concern of physical education classes differed by gender in order to determine whether, numerous studies are needed.

Students' attitudes towards physical education lesson when analyzed by gender (Table 2), a significant difference between boys and girls was observed. This finding limited number of trial paralleled the (Chatterjee, 2013; Subramaniam & Silverman, 2007), many research results that does not coincide (Akandere et al., 2010; Chung & Phillips, 2002; Kjonniks, Fjørtoft & Wold, 2009; Stelzer, Ernest, Fenster, & Langford, 2004; Şişko & Demirhan, 2002). The difference between the research findings may be due to the fact that the attitude scales used are not the same. As well as samples of the properties to be different, the girls grow where they, their parents attitude towards the course and level of education, the instructional methods of teaching such research to be covered latent variables also finding differences in cause is thought to be. Women to participate in the Olympic Games in Ancient Greece, and even where it is forbidden even to keep track, considering men than women may be assumed to have a positive attitude. Because of lifelong fitness habits from a young age gain, considering that the male body during puberty education and more active participation in sports activities, has brought a positive attitude. However, as of today be considered that this situation begins to change shape. As a result of the major factors to be formed in this way, together with social changes occurring nowadays women are more involved in sporting activities, and with it an increase in sporting success can be considered. In parallel to this increase in society, girls and adolescents as motivation in the face of this success, in that a positive attitude towards physical education and sports activities are thought to be influential in the development. However, for girls to lose weight and usually consists of just walking though they started to move their body in a way that is seen. Different genders secondary school students' physical education from the expectations upon a survey conducted, the physical education lesson developed with the physical appearance related to the objectives of secondary education for students is very important that have been identified (Yıldıran, Yetim, & Şenel, 1996). Daughter of the mass media in positive attitudes towards physical activity is thought to be the effect. Visual and written media dietitians often lose weight and stay in shape for the sport's emphasis on the importance to do, television, newspapers and magazines as well as the means of communication to more people arrive and these media outlets sports content the diversity of programs to increase such reasons in this direction, which is effective as factors considered. All these factors in the formation of positive attitudes towards sports in reducing the impact of gender factor. Also included in the study group of girls to their parents' attitudes towards physical education and sports activities can be considered as the effect on this result. As Silverman and Scrabis (2004) state that parents' attitudes towards physical education course are positive, they can facilitate the efficient processing of lesson activities for the students and make it easier for the students to achieve their specific and general goals, or to provide students with voluntary participation in various physical activities in the future.

Physical education trait anxiety subscales with physical education lesson attitude relationship between the level examined (Table 3), anxiety subscales of physical education attitude cognitive dimension with the low-level negative relationship was found. Thus, with increasing concern in primary school students in physical education lesson can be said that the attitude adversely affected. Related literature research has found thatscanned trait anxiety of elementary school students in physical education and physical education courses directly examine the relationship between attitudes. Therefore, it has not been reviewed compared with the findings of other research findings. However, the findings in other areas, concerns and attitudes examined the relationship between work, attitudes and concerns of a negative relationship finding that is in line (Baloğlu, Koçak, & Zelhart, 2007; DeVaney, 2010; Doğan & Çoban, 2009; Finney & Schraw, 2003; Hussain, 2011; Kurbanoğlu & Takunyacı, 2012; Onwuegbuzie, 2000; Yenilmez & Özabacı, 2003). The education of individuals or the environment they have developed due to the problems caused by negative attitudes, behavior, reflected over time, after a period constitutes a failure cycle. Individuals will not succeed in this case with prejudice is thought to increase the likelihood of experiencing anxiety.

Also somatic anxiety size cognitive processes with the size of a positive high level, anxiety size cognitive dimension positively with moderate and concerns size somatic anxiety size is positively correlated with intermediate having a relationship that has been found. Both cognitive and somatic anxiety concerns the size of the size of a positive result is expected to be in a relationship. Physical education trait anxiety scale concerns subscale statements contained in students' overall course related movements during the error to be made or misfortune will face the anxiety and examination regarding his concerns about the level of trait anxiety for measuring the statements (eg, I am very worried about physical education exams, physical education lesson in the I feel uneasy, fearing I will make mistakes). This condition may occur in a state of anxiety, and cognitive anxiety (e.g., I have difficulty focusing on movements in physical education lesson) and somatic anxiety (e.g., in physical education lesson while the movements my body aches) levels may cause an increase.

In the study, it was determined that trait anxiety subscale on the attitudes of the physical education lesson has a low level of effect size (Table 4). In addition, levels of trait anxiety in physical education lesson, the impact on attitudes towards the course is described by a ratio 3%. In the study, only physical education lesson continuously lowering of anxiety levels, attitudes towards the course has not proved sufficient to increase. Attitudes towards physical education lesson by researchers to investigate the factors affecting attitudes towards the course and to move to a higher level can be made more concrete proposals.

Studies examining the relationship between achievement and attitudes of students towards the course with the attitude of a student's success in those courses showed a close relationship between them (Büyüköztürk, 1999). Because of the close relationship between achievement and attitudes of all students by providing tasting success in physical education lesson, along with a sense of achievement in a positive attitude towards the course of the development can be achieved. Together in a positive attitude towards physical education lesson in trait anxiety will decrease. In the study of elementary school students have a positive attitude towards physical education lesson, despite this positive attitude despite the low level of anxiety was observed. In mathematics, a study conducted in the attitude towards the course along with students 'self-efficacy beliefs in a positive way to develop lesson concerns reduce the level (Kurbanoğlu & Takunyaci, 2012) as a result of considering the obtained results of the research of the students' self-efficacy low levels could arise from the possibility that suggests. In addition, a study done, which is more physically fit students, physical education and physical activity that results in more positive attitudes toward reached (Sherrill, Holguin & Caywood, 1989). This may help us to think that students are not able to prevent anxiety because they love the lesson and develop a positive attitude but are physically inadequate. These levels despite a positive attitude along with low levels of trait anxiety as the cause of the lack of parental attitudes and level of education, physical education teachers' approaches and attitudes in various factors such as the effect is thought to be.

However, it is thought that can bring to contribute to the field of study of a single province in the city center, in a selected group of students, it is preventing making and generalization of the results of the study group relatively small. The research of elementary school students in physical education lesson attitude towards the course of trait anxiety levels to determine the predictive power is the first study in the context of the future work to be done in this area and thought to shed light on this. Therefore, different samples are needed to work in the similar area. This type of study, students in physical education lesson trait anxiety and attitudes related physical education lesson is expected to be useful for a better understanding.

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Determining Ways of Thinking and Understanding Related to Generalization of Eighth Graders*

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Abstract

The main purpose of this study is to determine ways of thinking and understanding of eight graders related to generalizing act. To carry out this aim, a DNR based teaching experiment was developed and applied to 9 eight graders. The design of the study consists of three stages; preparation process in which teaching experiment is prepared, teaching process in which teaching experiment is applied, and analysis process in which continuous and retrospective analyses are carried out. Analysing the data, it was found that students' ways of thinking could be determined as relating, searching, and extending. Ways of understanding belonging to generalizing act could be determined as identification, definition, and influence. It was recommended to add two new categories "relating with an authority" and "searching the same piece" to the generalization taxonomy.

Keywords: Based Instruction, Generalization Taxonomy, Ways of Thinking, Ways of Understanding

Introduction

Learning occurs as a result of the equilibrium of one's mind. Mathematical knowledge, as well, is the product of this balancing process. Many researchers, despite often using different terminology, highlight the operative and conceptual structure of mathematical knowledge (Hiebert & Lefevre, 1986; Sfard, 1991; Skemp, 1976). One might argue, then, that mathematical knowledge and, therefore, mathematics itself are composed not just of axioms, definitions, and theories, but also of the conceptual tools that allow our minds to access this knowledge (Harel, 2008a).

Mathematics teachers are concerned with how students can improve their ability to learn and adopt different approaches in the classroom. DNR-based instruction (DNR is the acronym of duality, necessity and repeated-reasoning) is a teaching approach that seeks to provide answers to challenges which mathematics teachers continue to face. To do so, this approach focuses on improving ways of thinking and understanding of our mental acts. Problems are therefore perceived in a manner that considers students' intellectual needs as well as their willingness to solve problems. When students learn desirable ways of thinking and understanding, it is necessary to make this information permanent by repeated reasoning so they can integrate them into their academic lives.

Since the student and the student's knowledge formation processes are at the centre of teaching process, it is necessary to try to understand what is going on in their minds while investigating their generalization processes. Generalization strategies developed in the literature approach these processes from the perspective of a researcher. Based on actor-oriented transfer, Ellis (2007) investigated the generalization processes of students and interpreted this process from the perspective of the student. Additionally, the generalization process was examined as a process and product in line with the structure of mathematics, and the generalization taxonomy was developed. The aim of this study was to determine the ways of thinking and understanding of students while generalizing. Eighth-grade students were subjected to a DNR-based teaching experiment, and their generalization processes were analysed according to this taxonomy.

Theoretical Framework

Learning means using the knowledge (Piaget, 1964, p. 20). Learning mathematics requires the use of the acquired mathematical knowledge, and an improvement of mathematical thinking. Mathematical thinking involves many interconnected thinking styles such as geometrical thinking, functional thinking, and algebraic thinking. Algebraic thinking is related to noticing patterns and investigating the mathematical relations of numbers, objects, and geometrical shapes; therefore, they compose the basics of the mathematical thinking (Windsor, 2009). Two important components of primary school algebraic thinking are making generalizations and using symbols to show and solve problems (Carpenter & Levi, 2000).

Students intend to classify mathematical structures according to their appearances in order to make generalizations. The characteristics of generalization approaches conducted in later years involve making logical-mathematical inferences beyond their appearances, noticing relationships, and expressing these relationships with symbols. Therefore, in the process of learning mathematics and improving the ability to generalize, mathematical representation is very important (Carraher, Martinez & Schliemann, 2008). When students start making generalizations by observing patterns, algebraic thinking commences as well.

* This study has been obtained from doctoral dissertation titled as "Determining the 8th Graders Ways of Thinking and Ways of Understanding Related to Generalization: A DNR Based Teaching Experiment" completed by Gülçin Oflaz.

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Generalization is the core of algebraic thinking. Along with being an effective algebraic 'procept' (Gray & Tall, 1994, p. 95), generalization represents both process and product, is an irreplaceable instrument in the representation of mathematical modelling, problem-solving, and quantitative relations with symbols (Becker & Rivera, 2006). Indeed, generalization is understood as either product or process. However, generalization requires both product and process, as the process of generalization leads to an expression (Yerushalmy, 1993). This study regarded generalization as both a process (ways of thinking) and product (ways of understanding).

Ways of Thinking of Generalization Act

The ways of thinking of generalization act are the characteristics of one's cognitive process when one makes generalization. According to the literature, generalization strategies can be categorized as recursive thinking, explicit thinking, visual thinking, quantitative thinking, and pragmatic thinking in which both quantitative and visual thinking are included (Barbosa, 2011; Becker & Rivera, 2005; Chua & Hoyles, 2011; Lannin, 2004, 2005; Orton & Orton, 1999; Stacey, 1989; Zazkis & Liljedahl, 2002).

Recursive thinking is a technique used widely in pattern generalization problem-solving. Recursive thinking is the search for the mathematical relationship between the first term and the last term in a series. More generally, it is how a series is investigated in terms of whether the common difference between a series' sequenced terms is valid for every term in the series or not (Lannin, 2003, 2004; Stacey, 1989; Zazkis & Lildejahl, 2002). Even if recursive thinking is the first method used while finding the rule for a pattern, doing the same operation repeatedly is not sufficient. Therefore, one might argue that explicit thinking is recognized as more effective and efficient than recursive thinking.

Explicit thinking involves calculating the value of dependent variable according to the given value of the independent variable. Generally, algebra lessons given in schools involve finding a formula for a given problem. However, students may not necessarily have the required mathematical knowledge to find the correct formula. Therefore, the explicit and recursive thinking proceed as nested while finding a rule (Barbosa, 2011; Lannin, 2004, 2005).

Visual thinking is defined as explaining the shapes in a way to complete the series, even if they are not visible. It is generally used for geometrical data patterns (Friel & Markworth, 2009). Students who think visually focus on the structural properties of a shape. These students use visual images in their solutions (Becker & Rivera, 2005, 2006). For questions that require one to consider the structural characteristics of a shape, the focus can quickly move towards a "how many" question.

Becker and Rivera (2006) stated that those who prefer a quantitative approach while making generalizations use quantitative operations to find a rule. This approach requires turning the shape pattern of data into quantitative patterns and using these quantitative patterns to find a rule (Becker & Rivera, 2005; Chua & Hoyles, 2011; Tanışlı & Yavuzsoy Köse, 2011). The use of visual and quantitative thinking methods together is called pragmatic thinking (Kirwan, 2015, p. 29). Students who think pragmatically can think both visually and numerically (Becker & Rivera 2006; Tanışlı & Özdaş, 2009). Therefore, they benefit from both visual strategies and numerical strategies while finding the rule of a given pattern.

Generalization strategies developed in the literature can be mostly explained by means of the researcher-oriented transfer approach since the information regarding the previous situation to which the students establish a similarity relation cannot be obtained through such strategies. However, since the student is at the centre of the teaching process and the intention is to foster his/her knowledge of a particular topic, a classification giving more information what happens in students' mind when generalizing is needed. Ellis (2007) investigated generalization as a process (generalization actions) and product (reflection generalizations) and created her taxonomy, based on Lobato's (2003) actor-oriented approach. Lobato (2003) investigated how students form similarities among the problems encountered from learners' point of view. In this respect, Lobato (2003) shifted the transfer studies in the literature from the researcher perspective to the student perspective and added a new dimension to the transfer studies. The actor-oriented transfer gives important clues regarding how the brain establishes connections between new and old information (Lobato, 2003).

'*Generalization Actions' as Ways of Thinking*

A series of cognitive processes takes place in the brain while making generalizations. Ellis (2007) described this process as a characteristic of the generalization process in mind during the verbal or written action of a person, and classified this as 'generalizing actions'. For example, while a student is finding the rule of a pattern, s/he can solve the problem by 'relating' it to a pattern that s/he has seen previously or can solve by 'searching for the same pattern', or by making generalizations. Ellis (2007) identifies three categories of generalization approaches: relating, searching, and extending. These categories are interconnected and occur simultaneously. This classification was formed considering students' focus.

Students relate, or make connections between two or more events, situations, or problems when identifying pattern rules. The cognitive actions that take place while relating are random rather than purposeful. While looking for connections, the student is not aware that the relationship has already been established. When a student searches, s/he may repeat actions in order to identify similarities. The actions performed here are more purposeful. The student, aware of the possibility of similar relations, searches actively for similarities among many samples. If the student not only realizes the presence of a similarity relation, but s/he also explains with a more general structure beyond the given situations, s/he may perform extending.

'Reflection Generalizations' as Ways of Understanding

The ways of understanding of generalizing act are characterized by identifying the product; in other words, the generalization expression. The expressions are categorized as reflection generalizations. At the end of the generalization process, the student can produce a pattern, rule or a definition.

DNR-Based Instruction

DNR-based instruction is an approach that demonstrates what component of mathematics should be taught in schools to improve the success of students and how it should be taught. The answer to the question "What should be the content of mathematics taught in schools?" is hidden in the duality principle. Duality claims that the knowledge of mathematics comprises both ways of thinking and understanding, and ways of understanding produced are influenced by ways of thinking, and vice versa (Harel, 2008b). Because ways of thinking and understanding influence each other, the intention should be to improve both simultaneously. Understanding what is going on in the mind of the student and supporting his/her mental development is key to improving his/her ability to learn. However, it is known that more emphasis is given to the development of ways of understanding that express the product because of the factors such as exam anxiety and increasingly tight schedules for learning content (Baki & Kartal, 2004). The improvement of mathematical knowledge and, in this respect, mathematical thinking, is related to the development of these two types of knowledge.

Improving ways of thinking and understanding is related to the principles of necessity and repeated reasoning. According to Harel (2008b), the only way to learn is to solve problems, as we only experience disequilibrium in the mind when a problem is encountered. Individuals first take the new situation into his/her existing cognitive schema. However, when the new problem situation does not fit the existing cognitive schema, s/he forms a new cognitive schema by arranging the existing schema. Learning is a continuum of disequilibrium–equilibrium phases manifested by (a) intellectual and psychological needs that instigate or result from these phases and (b) ways of understanding or ways of thinking that are utilized and newly constructed during these phases (Harel, 2008b, p. 897). At this point, when the mathematics education dimension is considered, the mental and psychological needs of the student should be met in order for learning to be realized. Motivation, the interest towards learning, desire, and willingness compose the psychological needs. When a person faces a problem, it is necessary that s/he has the desire to solve the problem and show perseverance. On the other hand, the mental needs can be defined as providing the mental confusion state that enables obtaining new knowledge from his/her knowledge (Harel, 2008b, p. 898).

After the intellectual need is formed in students' mind to solve the problem and the desirable ways of understanding and thinking are developed, it is necessary for the student to internalize and organize this information by repeated reasoning principle. Cooper (1991) claims that repeated reasoning is necessary to form rich cognitive networks that are interconnected. Conflict should arise in the mind in order for new cognitive networks to be formed. It is difficult and complex for children to "do mathematics". Therefore, mathematical experiences are of critical importance in order for children to deepen their knowledge and comprehension regarding mathematics as well as their communication with their peers and teachers (Kieren & Pirie, 1991). The problems presented to students should not be routine or repetitive. On the contrary, the problems that students encounter must help students to internalize and reorganize the desirable ways of thinking and understanding they formed, and respond to the students' changing intellectual needs. In other words, problems should be presented in a way that triggers students' thinking.

In order to achieve effective teaching, the teaching process must be learner-centred. Therefore, in the process of forming knowledge, the cognitive functions that take place in the mind of the student are of great importance. A teaching process wherein the mental actions of the student are recognized and considered will be more effective in forming their knowledge. In this regard, determining how students understand and think in terms of their generalization processes gains importance. In this study, the generalization processes of students were investigated from the perspective of students. Therefore, the generalization taxonomy, which is based on the learner-centred approach, was used to analyse the generalization processes. At the end of the study, two new categories were recommended to be added to the taxonomy. This study is considered important both on account of the new categories proposed and on account of the fact that the study is based on what transpired in the students' minds.

According to DNR-based instruction, ways of thinking and understanding should be developed together. For this reason, the two-dimensional structure of knowledge should be taken into consideration. In addition, an instruction that fulfils students' intellectual needs and that provides students with the opportunity to internalize, organize, and modify this knowledge should be emphasized. It is thought that desirable ways of thinking and understanding can be improved in a student's mind, considering these factors. In this study, a DNR-based teaching experiment consisted of some algebra topics was developed and conducted in a classroom of eighth-grade students. Therefore, the goal was to determine the students' ways of thinking and understanding while making generalizations. In this regard, answers to the following sub-problems were sought:

1. What are the eighth-grade students' ways of thinking regarding generalization processes?

2. What are the eighth-grade students' ways of understanding regarding generalization processes?

Methodology

In this part of the study the design of the research, data collection tools, data analysis process were stated in detail.

The teaching experiment methodology (Cobb & Gravemeijer, 2008; Steffe & Thompson, 2000) was employed in this study to follow students' development and to determine ways of thinking and understanding when generalizing. The study consisted of three stages: preparation for teaching in which observations were made, the teaching experiment was designed, and the participants were selected; teaching in which pre-application was conducted, the teaching process was carried out, one-to-one interviews were conducted with students, and a continuous analysis was carried out; and analysis in which the data were studied retrospectively. Data collection process is given below (Figure 1).

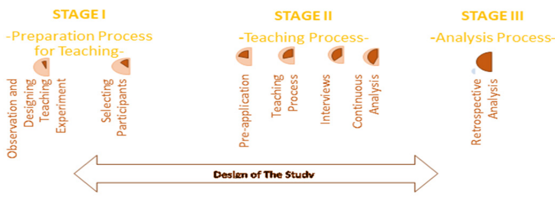

Figure 1. Design of the study

Stage I – Preparation Process for Teaching

During the preparation for teaching stage, classroom observations were made, the teaching experiment was designed, and the participants were selected. In order to determine the difficulties that students encounter in their algebra courses, the researcher followed and performed various teaching practices in seventh- and eighth-grade algebra courses for three terms during the 2014-2015 academic year and the autumn term of the 2015-2016 academic year in the school where the study was conducted. The topics of patterns and relations, the analysis of change, and equations were determined as topics of the teaching experiment based on students' difficulties that the literature points out. The teaching experiment lasted for seven weeks of which one week was allocated for the pre-application and six weeks were allocated for the actual sessions. During the teaching experiment, the students were asked to complete 37 tasks. The task distribution related to the subjects according to the week they were carried out is shown in Table 1.

Table 1. *Distribution of tasks according to the subjects and weeks*

	Subject	Tasks	Day	Mathematical Actions
1st Week	In order for the students to have an idea about how to study and to get accustomed to the camera, questions similar to those presented in the teaching experiment were studied.			
2nd Week	Patterns and Relationship	Task 1, 2	1st Day	Applying different ways to find the rules governing shape patterns
		Task 3, 4, 5	2nd Day	
		Task 6, 7, 8	3rd Day	Determining the rules governing number patterns presented in a table and analyzing the relationships
3rd Week		Task 9, 10	4th Day	Drawing a generalization about geometrical shapes
		Task 11, 12	5th Day	Discovering patterns in number tables
	Analysis of Change	Task 13, 14	6th Day	Investigating the concept of education in terms of analysis of changes
4th Week		Task 15, 16	7th Day	Analyzing relationships and showing them by means of tables and graphs
		Task 17	8th Day	Analyzing the relationships in a table, forming a rule, and switching between multiple demonstrations
		Task 18, 19	9th Day	Recognition of the velocity concept by means of the burning candle question; recognition of the relationship between slope and velocity by means of the robot's journey question
5th Week		Task 20, 21, 22, 23	10th Day	Investigating the changes of velocity concept in terms of analysis Drawing y=mx and y=mx+n lines
	Equaitons	Task 24, 25	11th Day	Recognizing patterns in tables and graphs
		Task 26, 27	12th Day	Interpreting the relationships between non-linear variables Writing equations for the lines presented on given graphs
6th Week		Task 28, 29	13th Day	Showing the relationship between two variables in the form of a curve Writing an equation for the problem given verbally
		Task 30, 31	14th Day	Interpreting linear and non-linear relationships in a table Drawing graphs with different shapes (such as column graph)
		Task 32, 33	15th Day	Showing and explaining the relationship between variables in a table in the form of equations and graphs Analyzing various solutions for problems given verbally and showing the relationships on a graph
7th Week		Task 34, 35	16th Day	Showing and interpreting two lines on a graph, one of which is increasing and the other is decreasing, Writing equations or showing in graph form the relationship between two variables in comparison with one another when a constant is given
		Task 36, 37	17st Day	Writing equations for a problem given verbally, showing the decreasing line for the problem in a graph and interpreting the relationship between two variables given as points in a coordinate system, in terms of comparing them

As shown in Table 1, the teaching experiment lasted 6 weeks, with the first week being used for pre-implementation and the remaining 6 weeks for the main implementation. Among the implemented tasks, 12 focused on patterns and relationships, 15 on analysis of change and 10 on equations.

Selecting Participants

The study was conducted with 9 eighth-grade students. Operational and conceptual algebra tests developed by the researcher were administrated to a total of 167 eight-graders from the participating school which was a public middle school located in Sivas. The operational algebra test featured 10 questions, which were prepared considering seventh- and eighth- grade-level algebra objectives. This test composed of open-ended and non-routine problems. With this test, the aim was to investigate how students solved algebra problems. The conceptual algebra questions implemented in this study were prepared according to Küchemann's (1981) algebraic thinking levels. The purpose of using conceptual algebra in this study was to discern the students' knowledge of algebraic concepts and thereby determine who would participate in the teaching experiment. For student selection, the criteria were that the student must have a certain background in algebra and possess a certain level of algebraic thinking. Therefore, in this study, the classification of letter symbols and the algebra test, which was composed of questions prepared by the researcher in light of the algebraic thinking levels corresponding to the study's aim, were used.

The students' answers to the tests were categorized as high, moderate, and low according to the number of correct answers. The participants were selected from the high and middle categories by their mathematics teacher. The mathematics teacher applied the inclusion criteria of being capable to reason in mathematics problems and of expressing his or her thoughts clearly for the study. Therefore, the study was conducted with a total of 9 students (four males, five females). Pseudonyms were used for the participants throughout the study.

Stage II – The Teaching Process

This stage consisted of pre-application, which aimed to improve students' familiarization with studying in front cameras and informed students about how to study; the teaching process in which the teaching experiment was carried out; one-to-one interviews, which were conducted with two students at the end of each session, the evaluation of the day by the teacher and researcher at the end of each day; and the continuous analysis consisting of the changes of work share if necessary.

The sessions were conducted by applying the following steps: First, each student was given a worksheet describing the tasks and then instructed to study the tasks individually. Following the individual study, group discussion sessions started, where the sharing of ideas by each of the students served to create a group discussion environment. At this step, the researcher and teacher walked among the groups, listened to the discussions, and asked questions to help direct the discussion. After ensuring that all of the students had the opportunity to talk about their ideas, a class discussion was conducted to think about possible methods for reaching solutions. The researcher asked "puzzling" questions during both group discussions and class discussions to explore the students' minds and to help them better express what they thought. In this way, each student's proposed solution was discussed, and the methods of reaching a solution were identified. The implementation of the teaching experiment was carried out first by placing participants into groups of three. The study was conducted three days a week during a six-week period after school in mathematics classroom. Each session lasted between 70 and 100 minutes. Sessions were recorded by four cameras; one camera recorded each group and one recorded the entire classroom.

At the end of each session, two or three questions were given as homework in order to encourage students' repeated reasoning of the related topic. Therefore, students' homework was used as a means of supporting their ways of thinking and understanding as well as providing their repeated reasoning.

Interviews

After each session, one-to-one reviews of the homework of each day were conducted with Ali and Gül. One-to-one interviews were conducted with these students and recorded. Each interview session lasted between 15 and 90 minutes.

Continuous Analysis

The overall data analysis consisted of two stages: continuous analysis and analysis of all data obtained at the end of the study. The continuous analysis was conducted through the researcher's and teacher's evaluation of each stage. The continuous analysis allowed the researchers to investigate whether the implemented teaching experiment of the day facilitated the target change in students' understanding and to make the necessary adaptations for the future application (Molina, Castro & Castro, 2007; Simon, 2000). At the end of each session, the teacher and researcher exchanged ideas, and a brief analysis of camera records and students' worksheets were made in order to arrange the task to be included in the next lesson.

Data Collection Tools

The second stage in which the teaching experiment was implemented also included data collection. The camera records of each session, camera records of group studies containing students' discussions, one-to-one interviews with two students after each session, interviews with each student about their opinions of the teaching experiment process, students' worksheets, students' logs, and the observation notes of the teacher and researcher constituted the data collection tools.

Data Analysis

The camera records were transcribed using the continuous and retrospective analyses. Content analysis was used to analyse the students' worksheets, logs, and the researcher's and teacher's logs. Data analysis process also constituted the third stage of the study.

Retrospective Analysis

The retrospective analysis was the last stage of designing the teaching experiment. It is the process of evaluating the data within a more comprehensive theoretical framework (Cobb, Jackson, & Dunlap, 2014, p. 20). The data obtained in this study were quite comprehensive since the data collection tools were varied and included qualitative data such as video records of various occasions, students' worksheets and logs, the researcher's notes, and teacher's logs (Molina, Castro & Castro, 2007).

The video records obtained were transferred to the Camtasia Studio 9 software. Therefore, it was possible to view the four different camera records of each lesson and to listen at the same time what was spoken in groups while holding a discussion. Powell, Francisco, and Maher (2003) developed a model to analyse video records obtained in order to determine the development in students' mathematical thinking. Being designed to examine the development of mathematical thinking, this model consists of 7 interrelated steps that are nonlinear. The video records obtained within the scope of this study were analysed considering this model.

Content analysis method was used to analyse the data obtained from the students' worksheets, logs, and the researcher's and teacher's logs. NVivo 8 software, a qualitative data analysis program that facilitates coding, grouping, and linking of data (Kuş, 2006), was used in the process of forming themes and categories.

Results

In this part of the study, the findings were arranged in accordance with the sub-problems. According to this, firstly the ways of thinking about the generalization process of the students and the ways of understanding that the students revealed after the generalization processes were determined. The findings were supported by students' expressions and worksheets.

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Students' Ways of Thinking Regarding Generalization Processes

The aim of the tasks regarding patterns and relations was to enable students to develop different ways of thinking to find the rules of patters presented as figural or number; to recognize relations in patterns presented in multiple representations; and to express these relations algebraically and verbally. The aim of the tasks regarding the analysis of variance was to enable students to investigate the variance of variables presented with multiple representations such as algebraic, verbal, table, and graphic formats according to each other, and to demonstrate this variance with multiple representations. The aim of the tasks regarding the equations was to enable students to demonstrate the variances that they analysed with multiple representations such as algebraic, verbal, table, and graphic formats. Approximately 250 generalization actions were coded. Examples from each generalization action were presented in this paper since it would not be reader-friendly to include all generalization actions.

Relating

Relating is achieved when a student creates a relation or establishes a connection between two or more situations, cases, or problems. The actions performed within the category of relating are random rather than intentional. When a student looks for a relation, he or she does not know how this relation is established. Relating is achieved by either connecting situations or objects.

Relating Situations

A student engages in relating situations if the act of relating involves two or more problems or situations. The situation in this context is anything that is perceived by the students as a situation. A student might perform connecting back if he or she relates a new situation with the existing problem, example, or situation. For example, one of the tasks was about finding the rule of a pattern of which the first three steps were given. The students attempted to discover the rule differently from their teacher's method.

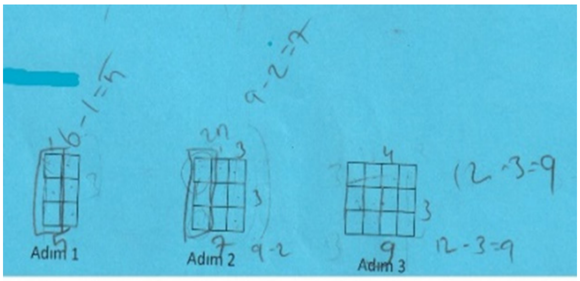

Figure 2. Bartu's worksheet

Bartu: I made all closed figures by adding a square to each. For example, if we add a square in the middle, it becomes a rectangle. The second figure becomes a square by adding two squares in the middle. It becomes a rectangle again if we add three squares to the third figure.

Ezgi: It is like a rectangular number. Then, it goes like a rectangle, a square, a rectangle...

R: Rectangular numbers?

Ezgi: The numbers that we wrote as a rectangle.

Ezgi established an effective relationship between the square numbers and the figures and connected back since she related with her existing knowledge. Despite inaccurately expressing her relation, students' focus is the foremost point. The mathematically inaccurate nature of the situation to which the student relates does not pose an obstacle to the examination of this situation.

A student might develop a new situation that is similar to an existing situation and establish a relation with this new situation. In this case, this student is said to relate with a new situation. When students were asked "to figure out a scenario whose equation can be formulated as y=6" in one of the tasks, Koray answered, "There are 1-million stores. If this would be a 6-million store, the relation between the goods and their price would be y=6. In this case, toys are 6 liras and Cokes are 6 liras". Therefore, the equation was related with a new situation.

Relating Objects

A student might establish relations between mathematical objects on the basis of the similarity of two or more equations, graphs, tables, problems or other objects. The relationship can also be established through assimilating mathematical objects to each other in a visual or formal way.

One of the tasks was about finding the rule of E pattern, the first two steps of which were given, the students connected back with the rule found on the previous day. They attempted to find the area of the figure by adding squares in order to make it a complete figure.

Sezen: There are 15 squares in the first and 28 squares in the second if we complete the area. Later we need to subtract the ones we added.

Melike: There are 15 in the first. We will take out 4... Consider that we should reach this formula (the formula that they found by applying the existing formula).

R: Can you express what you have said as a rule?

Bartu: In the previous lesson, we calculated the area of the rectangle; yet, the short side was a constant. In this case, however, both short and long sides increase.

Sezen: The long side is five in the first figure and seven in the second figure. It increased by two. Therefore, the rule becomes 2n+3.

R: What do you say about the short side?

Gül: 3, 4, 5. It increased by one. Then, the rule is n+2.

R: How many unit squares are there in the rectangle I created?

Ezgi: We calculated the area yesterday. What is multiplied by what?

...

Oğuz: (2n+3) is multiplied by (n+2).

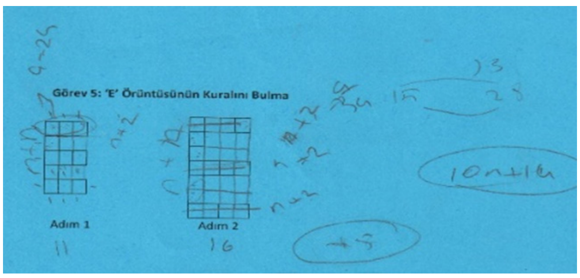

Figure 3. Melike's worksheet

The students established a formal relation between this problem and the problem solved on the previous day; however, they encountered difficulties with the solution.

The solution for the previous problem dealt with the area of a rectangle based on the number of square units it contained. However, the students first initiated a solution by searching two quantities to be multiplied since they had not yet learned the area of a rectangle by relating it with the number of square units included in this rectangle. Later, Oğuz stated that the area could be found by multiplying the short and long sides and, in doing so, related the property.

One of the tasks was about renting DVDs from the most appropriate of three different stores that offer different fare schedules. The students formulated the fee each store charged for one DVD. Bartu designed a table in order to clearly see the three different prices. According to this table, he found the rule regarding the price to be paid to each store and the number of DVDs. Later, he wrote the equations stating the relationship between the number of DVDs, the store, and the corresponding prices.

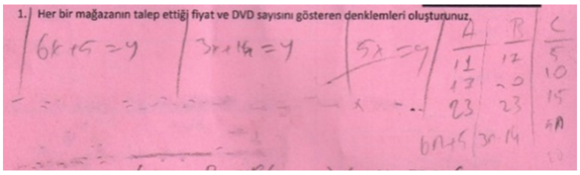

Figure 4. Bartu's worksheet

Bartu examined the table and his equations. Then, he noticed that the rules regarding the relationship in the table and his equations were the same. "The rule we found is the same with the equation we wrote. We wrote n in the rule, and substituted x with n and equalized to y," he said. Bartu realized that finding a rule for the relations in any table and expressing these relations algebraically is the same procedure and shared this with his peers. Therefore, Bartu connected the formal property of the equations with the rules of the patterns he found in the table.

Relating With An Authority

In the task in which the first three steps of the figural pattern were given, and its rule was asked, the students found the rule by transforming the figural pattern into a number pattern. When asked how she found the rule, Melike, like her friends, expressed the rule in the following way:

> *Melike: If we transform them into numbers, they become 4, 7, 10, 13. The difference between them is three; that is to say, 3n. We need to add one to get the first term. The rule becomes 3n+1 if we add one. This holds true for the other figures.*
>
> *R: How did you find this?*
>
> *Melike: Our teacher taught us to do it this way.*

All of the students found the rule of the pattern in this way and explained that "their teachers had taught them in this way". The actor-oriented transfer provides important clues about how an individual relates new situations with the existing cognitive structures in his/her mind (Lobato, 2003). Therefore, the student's focus becomes crucial in this process. In the relating stage of generalization, students relate two or more existing problems and situations based on their properties or formal properties in particular. However, the relations that all of the participants made are different than a problem, rule, or formula that was previously encountered. When finding a rule, students often related it to an authority figure, which, in this context, could be a teacher, textbook, etc. Therefore, this category is included in the stage of relating as relating with authority.

Searching

A student might repeat the operations in order to find similarities. The actions performed at this stage are, therefore, more intentional. Students search for similarities among many examples with the awareness that there is a similarity between them. For example, a student might search for the same relationship based on the examination whether the ratio of the given quantities remains constant. A different student can find the ratio of the given quantities but might not be able to speculate on this ratio. The student who carries out the similar procedure that is taking ratios repeatedly might search for the same procedure. Although searching for the same relationship and procedure are similar to each other, the decision into which category the action carried out falls is left to the researcher. For example, a student might search whether the pattern stays constant in a given task. However, the student cannot think beyond the given situation. Therefore, he or she might search for the same pattern. Students focus on the operations in all three categories. However, students' focus is sometimes the result of the operations, which they carry out to get the same result repeatedly. In such cases, students perform the action of searching for the same solution or result.

During the task in which the first three steps were given and its rule was asked, the students completed the figure to a rectangle by adding squares (Figure 3). Later, they found the rule by subtracting the number of unit squares they added from the total number of unit squares included in the rectangle. Gül and Ali expressed their thoughts and Ali put this rule into words:

> *Gül: If we determine the total number of small squares in these rectangles, and subtract the squares we added from this number, we can find the total number of squares.*
>
> *R: How can we find the number of small squares in the rectangle?*
>
> *...*
>
> *Ali: The side lengths of the unit squares in the rectangle are one unit. Therefore, in the first figure, the long side is three units and the short side is two units. This holds true for the other figures.*
>
> *R: How do we know that?*
>
> *Ali: I remember that our teacher solved a different question in this way. We thought that there were tiny squares in the rectangle and found the area.*

Gül aimed to find the number of squares in the figures by subtracting the number of squares added from the total number of squares included in the completed figure. Therefore, she searched for the same procedure by establishing a relation with the formal property of the rectangle. Ali, on the other hand, stated that the number of squares included in a rectangle can be determined by assuming the size of the square is one unit, like his teacher once demonstrated. Therefore, he expressed that a rectangular area is equal to the number of unit squares included in this rectangle. The rule expressed by Ali, by relating with an authority, is characteristic of the process of searching for the same relationship.

In one of the tasks, students were asked to think on situations that there cannot be talked about slope. The students stated various situations that slope cannot be achieved. Then the researcher raised the following question: "Let us imagine a distance-time graph. The time is constant, does not change; however, the distance increases continuously. For example, imagine that the distance travelled in the third second continuously increases. Would that be possible?"

> *Oğuz: It would not be possible. The distance I travelled in the third second cannot increase by five, six, seven meters because I cannot be in different places at the same time.*

In this task, the students agreed that the distance travelled cannot increase when the time is constant. However, they had difficulties in demonstrating this idea using a graph to state that when there is no change in the x-axis, a change cannot exist on the y-axis. Thereupon, they assumed a constant x point and established a line by combining it with the y value, as established in the previous example. Therefore, the students searched for the same pattern in order to determine whether the pattern applied to the new problem. In doing so, they discovered that the slope could not be achieved since this situation is contextually impossible.

The students considered an alternative approach when working on the task in which the first three steps were given. After working on it, Ali put the "3n+1" rule of the pattern in a different way:

> *Ali:* $\frac{9n+3}{3}$ *works out as well.*
>
> *R: How did you find that?*
>
> *Ali: By trial. Let us substitute 1 for n. Nine times one, plus three equals 12. Divide this by three, and the answer is four. Here is the first term.*
> *Now, I realize that* $\frac{12n+4}{4}$, $\frac{15n+5}{5}$ *can work out, too.*

Ali proposed this rule by relating the number of squares in the steps rather than assuming that multiplying and dividing 3n+1 by the same number would not change anything. Ali's action can be considered under the category of *searching for the same solution or result.*

Searching the same piece

In the task in which the first three steps of the figural pattern were given, and its rule was asked, Sezen found the rule for the pattern in the following way:

Sezen: I have noticed that there are one, two, three, four boxes here (the number of boxes in one row above the steps). There are one, two, three, four boxes here (the number of boxes in the middle row of the steps). There are two, three, four boxes here (the number of boxes in one row below the steps).

R: Can you transform this into a rule?

Gül: The pattern is as follows (for the number of boxes on the above, middle, and below rows in the first step): one, one, two; two, two, three. Then, it becomes n, n, n+1. If we add them up, it is 3n+1.

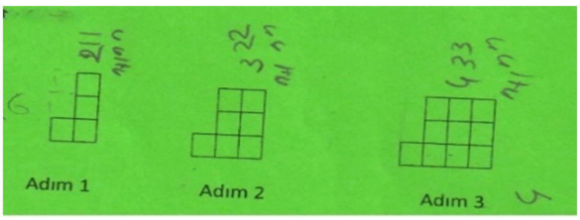

Figure 5. Gül's worksheet

Sezen and Gül broke the pattern down into pieces, related the number of boxes in the pieces with the step number, and derived a rule from this relation. The students' action in this example was different than investigating the relation between the terms composing a pattern. The students' focus here was on the pieces comprising the pattern. Their action was, therefore, to investigate whether these pieces were repeated in all terms and whether this change was constant. This action was thought to be different than the actions which exist in the categories of *searching.* Therefore, this action was added to the taxonomy as the category of *searching the same piece.*

During a different task in which the first three steps were given and its rule was asked, the students developed different ways of thinking. Ali found the rule in a different way and described his approach as follows: "Each step has as many rows and columns as the number of steps. One row, one column in the first step; two rows, two columns in the second step. There are three points in each row and column, which makes six points in total. I multiplied the step number by six. Then, I excluded one point since I counted it twice (the point on the intersection of row and column). I also found the rule for the points I counted twice: 2n-1. I subtracted 2n-1 from 6n. Finally, I found 4n+1".

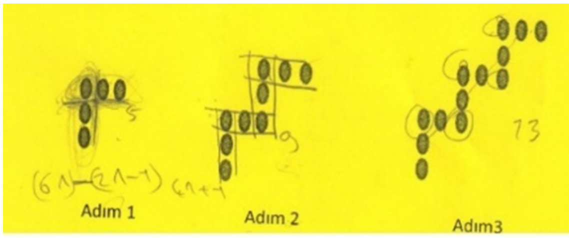

Figure 6. Ali's worksheet

Ali first found the increasing units based on the relation between terms. Subsequently, he broke the term into pieces and found a rule based on the individual units. In other words, he broke the terms into pieces that constitute the term itself, investigated whether these pieces are constant in other terms, and subsequently expressed this rule algebraically. Therefore, Ali's approach was found to be different than investigating the relation between terms and considered under the category of *searching the same piece.*

Extending

A student might perform the action of *extending* if s/he is not only aware of the existence of a similarity relationship but also expresses this relation in a more comprehensive manner that goes beyond the given situation. The extending action leads to a new relation, construction or definition. A student is said to *extend by expanding the range of applicability* if s/he applies the relation to other cases. A student might sometimes *extend by removing particulars* in order to create a situation that is more general than his / her generalizations. The aim of this extension is to identify a general phenomenon that is accurate for every object in a classroom setting. The student can extend and apply the relation to new examples. Therefore, s/he performs *extending by operating*. The student is said to *extend by continuing* an idea or pattern if the pattern is applied repeatedly. What is essential here is to focus on a constant pattern and continue without altering it. The student's focus is on the relation that causes the pattern.

Prior to working on the task regarding the journey of Curiosity to Mars, a short video about the Curiosity Rover was presented to the students. Students were asked to think about the task presented in the lesson and to imagine the scenario. In this task, the change of Curiosity's distance from the world was given by a distance-time table and some questions were asked about the table. The students speculated about the variance of the velocity of Curiosity and attempted to reach a solution by comparing the differences of the values in the table.

> *Elif: The slope is constant if the ratio of the differences among them is constant; otherwise, it is varied.*
>
> *Ali: The slope was eight, nine, and then 10, up to 40 seconds. The velocity was first constant, but then it increased.*
>
> *R: What would you say about the distance travelled in a unit of time?*
>
> *Elif: The distance travelled by a unit of time is eight kilometres up to the fortieth second, and then it increases.*
>
> *Koray: Then, it left a module to accelerate on the fortieth second. Afterwards, it left another piece to accelerate.*

Students first speculated about the slope by comparing the differences in numbers. Afterwards, they *extended by operating* by relating the knowledge that the distance traveled in a unit of time is equal to the velocity. Therefore, they agreed that the velocity is constant up to the fortieth second, and then increases. Koray, on the other hand, by relating with the video he watched, thought that Curiosity accelerated since it left a module and accelerated more by leaving another piece.

During the task regarding Curiosity's journey to Mars, students attempted to demonstrate the information presented in the table in a graph. All of the students created accurately the velocity-time graph. Bartu volunteered to draw the Curiosity's distance-time graph.

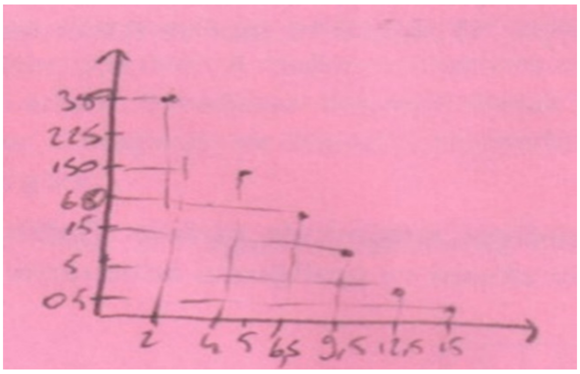

Figure 7. Bartu's worksheet

Regarding this graph, the students made the following comments:

> *...*
> *R: What is your independent variable?*
>
> *Oğuz: Time, because it changes independently from others. It also influences the distance.*
>
> *Ali: We solved the problem like we did in the previous lesson. As Curiosity fires from the earth, it moves away from the world. Therefore, the graph would be like this (he draws an increasing line in the air with his hand). However, since it gets closer to Mars, the distance gets even smaller. Therefore, it must be a decreasing graph (line).*

Oğuz determined time as the independent variable. Ali made a connection back to the graph drawn in the previous question. Ali stated that this must be a decreasing graph since the distance to Mars gets smaller, considering that since the distance to earth increases, it must be an increasing graph. Therefore, he *extended by continuing.* Koray, on the other hand, pointed out that the points demonstrated by Bartu should be drawn as a line. He justified his argument as follows: "In the previous lesson, if the line holds true for all the points between, a linear line should be drawn. The distance here always decreases. Therefore, we need to combine the points." Koray established a relation by making this connection with the previous lesson. He *extended by removing particulars* by expressing for each x on the line, the corresponding y values also provide the line.

> *Ezgi: We expressed this as a line. Its slope becomes constant at every point, 350/15. Therefore, the velocity is also 350/15. However, we found the velocity different at every interval; a bit increased, a bit decreased.*
>
> *Bartu: I also noticed that, but I could not decide whether to decrease by the same amount, to decrease a bit more, or to decrease more from which one.*

Ezgi found the slope of the linear line and related it to the Curiosity's velocity. She expressed that the line will be broken at the points where the velocity of the robot changes since Curiosity's velocity is different at different time intervals. At the time intervals where the Curiosity's velocity is high, the line becomes more perpendicular; at the time intervals where its velocity is low, the line becomes more sloping. Therefore, she *extended the range of applicability.*

Students' Ways of Understanding Regarding Generalization Processes

Any kind of product that is revealed as a result of individuals' mental actions is described as a way of understanding of those mental actions. In this regard, a solution to a problem or a proof constitutes ways of understanding of the mental acts of problem-solving or proving. Reflection generalizations indicating the products generated as a result of generalization actions are divided into various categories according to the product that the student reveals. According to reflection generalizations, the written and verbal generalization types expressed by students are investigated within the categories of identification or statement, definition, and influence. Reflection generalizations are quite related to the generalization actions.

Identification or Statement. Students can reveal generalization products by identifying similarities between expressions of situations, properties, general rules or patterns, strategies or procedures, and global rules.

Identifying the Continuing Phenomenon

Students can provide explanations for a continuing property that occurs in their generalization expressions. For example, in the task about the graph demonstration of the possible side lengths of a rectangle whose circumference is 18 units, the students first determined the possible side lengths and presented them in a graph. They combined these points along a line, indicating that each x and y value prove this equation. If the expression used in the generalizations indicates a dynamic relation, a generalization of identifying a continuing phenomenon is said to be performed.

Identifying Sameness

Students can express similarities between two situations, problems, and objects as a product of generalization. The problem or situation that is expressed as similar in this context is done so from students' points of view. The problem or situation that is the students' focus can emerge as the similar property, objects/representations, or the expression for the similarity between the situations.

Sameness of Common property. The possibilities were pointed out regarding the following task: "The distance travelled at certain time intervals by Melike who travelled equally long distances in the same time intervals as Feyza, where Feyza travelled 16 meters in 10 seconds". When the students were asked how they found the answer, they replied that all numbers were obtained by multiplying and dividing by 10 and 16 with the same number. As seen in these examples, the students reached a generalization by expressing the common property between two situations.

Sameness of objects or representations. Regarding the rules of patterns provided during the first days of the teaching experiment, Ali, Bartu, and Enes expressed that the pattern's rule, which is 3n+1, can also be written as '(9n+3)/3, (12n+4)/4, (15n+5)/5, and (18n+6)/6'. When they are asked why they provided alternatives, Enes stated that these also indicate the same rule since dividing or multiplying 3n+1 by the same number does not make a difference.

Sameness of situation. During the task that involved a rectangle with a circumference of 18 units, and its possible side lengths unknown, regarding the slope of [AB], Ali constructed ABD right triangle where [AB] is the hypotenuse. Then, he defined the slope as the ratio of adjacent side to the opposite side since the tangent of the ABD angle gives the slope. Elif answered this question incorrectly. When she was asked about the slope of [BC] by the researcher, she constructed a right triangle where [BC] is the hypotenuse with a thought that these situations are similar. Therefore, she was able to answer the questions correctly.

Identifying a General Principle

Students can express general rules, patterns, strategies, or principles in these situations by utilizing their generalizations. Generalizations obtained in this way are the most widely accepted by mathematicians when they are also expressed in algebraic form. General rule, pattern, strategy, and global rule in this context are all considered under the category of general principle.

General pattern. On the first day of the teaching experiment, Oğuz's reasoned the following: "If we take one square constant, other columns increases in every term. There are triple blocks as many as the number of steps in every term". His argument here regarding the pattern rule given in the first task can be considered as an explanation of a situation increasing among terms.

General rule. Regarding the possible side lengths of a rectangle whose circumference is 18 units, the students expressed the number pairs as (1,8), (2,7), (3,6), and (4,5). More generally, Ali found a rule indicating that x +y=9 if 2x+2y=18, where x is one side, the other side is y, and expressed this rule as "the integers whose sum is 9".
General strategy or procedure: The possibilities were pointed out regarding the following: "The distance travelled at certain time intervals by Melike who travelled equally long distances in the same time intervals as Feyza, where Feyza traveled 16 meters in 10 seconds." When they were asked how they determined these numbers, Koray explained his reasoning as follows: "Since she travelled 16 meters in 10 seconds, dividing them by two, it makes eight meters in five seconds. I can find the distance travelled by Melike at a time by multiplying or dividing the (5, 8) number pair with any number". Koray first determined the smallest number pair. Then, he expressed that he can reach the asked number pair by dividing and multiplying this smallest number pair with any number. Therefore, Koray applied a more general strategy independent of any object.

Global rule. One of the tasks was about finding a rule of some polygon's (triangle, square, pentagon,...,n-side) number of sides, number of diagonals, sum of interior angles. Ali found a rule for finding the number of diagonals of the polygon's and gave the following explanation: "A pentagon has five corners. A corner itself can neither create a diagonal itself nor can it create a diagonal with its two adjacent sides. Therefore, we can draw two diagonals from one corner, which makes 10 diagonals in total from five corners. Since we count all of them twice, we divide them by two. Therefore, it makes five diagonals". Ali, in fact, explained, by reasoning, how to find the number of diagonals using the combination.

Definition

Students might make definitions by expressing the basic characteristics of a pattern, object class or relation on which they work as a result of their generalization actions. Even though it seems unlikely for primary and elementary school students to reach a definition thinking an object class, the definitions mentioned in this context might not necessarily be mathematically accurate or complete. The expression of the basic characteristics of the pattern, class, and relations to the extent noticed by students is considered in this category. In the task where some polygons were given and the rules of numbers of sides, diagonals of polygons were investigated, Melike asked her friends what a diagonal was. In response, Bartu offered the following definition: "From one corner to the other". Ali stated a more accurate definition: "A line segment from one corner to a corner to which it is not connected".

The students investigated the variance of time and distance in the table indicating the change of Feyza's distance to home with respect to time and stated that the ratio of these differences is constant. The students noticed that the distance travelled in a unit of time equals the distance travelled in one second by relating the ratio of differences to the slope. The students stated that if someone travels an equal distance in every second, s/he walks with a constant velocity. The students both noticed the relation between the slope and velocity and provided a definition of velocity, which is the distance travelled in a unit of time.

Influence

A student might use a generalization that was previously obtained as a result of a generalization action in problem situations encountered for the first time. This situation can be confronted in two different ways: either the student makes a new generalization using the previous generalization, or the student makes a new generalization altogether.

The influence of prior ideas. This notion refers to generalization by using prior knowledge in new problem situations. If a researcher does not have much information about the mathematical history of students, the identification of prior ideas can be difficult. In the session in which the slope was discussed, the students talked about various meanings of the slope. Volkan, on the other hand, defined the slope as "tangent 30 or 60." When he was asked about the reason, he said that they used a similar approach in previous problems. He applied his prior knowledge, that tangent 30 or 60 gives the slope, to this context. Therefore, he expressed his idea under the influence of his prior knowledge.

Modified ideas or strategy. Students tend to adapt their existing knowledge as a result of making generalizations to accommodate a new problem situation. Therefore, they modify their existing knowledge. As mentioned previously, Volkan answered the question with his prior knowledge that tangent 30 or 60 give the slope. In the rest of the discussion, various comments on the slope were made and explained. Regarding the analytic geometry dimension, the teacher drew a line on the board and asked for its slope. The students defined the slope as "opposite divided by adjacent", using their existing knowledge. The students were then encouraged to think about this existing knowledge with relation to the angle the line makes with the x-axis. They finally reached the conclusion that the tangent value of the angle gives the slope. Therefore, they developed new knowledge by modifying their previous understanding of how to calculate the slope.

Conclusion

In this study, the thinking and understanding ways of eighth-grade students were determined. In evaluating the teaching experiment process through a holistic view, the following conclusions were reached: The first five tasks in the teaching experiment were on finding the rule governing given patterns. The first days of the experiment involved the students converting shape patterns into number patterns, followed by finding the rule governing the pattern by means of relating it to the rule that their teachers taught. The process of coming up with this pattern result generalization (Harel, 2008a) serves to demonstrate a way of thinking, as the students' focus is on the result of the actions they have taken. However, by the time the students were at the end of the subjects about patterns and relations, they had discovered the rules governing the patterns by thinking in different ways and were observed to be successful in interpreting the relations between the terms. Finding the rules governing patterns from the relationship between the terms is considered as process pattern generalization (Harel, 2008a). This is because the students focus switches from finding the rule according to a formula to finding the rule by means of interpreting the relations. Study on the subjects of patterns and relations lasted 2 weeks, after which the students were able to recognize the relations by thinking in different ways and grew to enjoy the process.

The tasks in which change are analysed through interpretation of the relations are quite important in the process of generalization (Booker, 2009). The sixth day of the teaching experiment started out with a study of the slopes of certain lines according to the analysis of change. During the teaching experiment, the thinking process involving the idea that the slope should be considered in the analysis of changes functioned as one of the most important knowledge acquisitions to be formed by the students. In the first tasks related to this subject, it was observed that the students thought that in the number tables given, there was a relationship between x and y columns only. But after a few tasks, they recognized that, in addition to the relationship between the x and y slopes, intra-relationships on the x slope and the y slope also existed. The students were then able to make comments based on these newly discovered relationships. This development can be considered as a transition from product-oriented thinking to process-oriented thinking. Furthermore, another relationship that the students eventually discovered and were able to recognize on the subject of analysis of change was the one existing between velocity and slope. Here it is important to point out that once they identified this relationship between velocity and slope in the analysis of change, they were able to reach the definition and formula of velocity. On the eleventh day of the teaching experiment, the analysis of change tasks were completed, with the results showing that the students had great success in recognizing the relationships and in interpreting whether changes remained stable or not.

In the tasks on equations, the aim was that the students be able to show the changes they analysed in multiple representations, such as algebraic, table, and graph form. The students had been accustomed to expressing these relations either verbally or in tables in their previous tasks. As one of the key knowledge targets of this study, the students were expected to be able to recognize that a rule (e.g. 3n+1) they had discovered to govern a pattern showed a relationships between two patterns, and from this, they were expected to understand that they could write this relationship between variables in an equation. By the end of the teaching experiment, they recognized that the pattern rule they found stemmed from an analysis of changes in the variables in terms of their initial values, and that any of the equations they encountered thereafter involving these variables did not invalidate the rule they found at the beginning. The students considered this idea to be very interesting and qualified it as the "beauty of mathematics". However, with that said, they experienced certain difficulties in trying to show these relations on a graph. Yet, at the end of the teaching experiment, it was observed that the students had overcome the difficulties they experienced in showing the relations on a graph. Similarly, Elia and Spyrou (2006) reported that in their study, the students had high levels of success in algebraic expression of function but difficulties in expressing this on a graph.

Ellis (2007), in his study on generalization taxonomy, recommended that this taxonomy be used in different subjects and on different samples to observe whether the taxonomy works well with different subjects and patterns. Therefore, in this study, the sample, the teaching experiment, and the algebra subject were changed, and based on an investigation of the answers given by the students, it is recommended that two additional categories need to be added to the taxonomy.

As a result of the teaching experiment, students' ways of thinking regarding the generalization processes were found to consist of relating, searching, extending, and the ways of thinking determined in these categories. The generalization process begins with the recognition of a similarity between the given case, situation, and problem. Associating the similarity between 'what' and 'what' is investigated in the category of relating. This similarity is established from the student's point of view. Since students are at the centre, their focus becomes crucial. On the first day of the teaching experiment, when the researcher asked the students how they solved problems and found rules of patterns, they replied that their teacher had taught them this way. The students related the problem they encountered with a rule taught by an authority rather than relating two problems or mathematical objects. Those who are based on the opinions of an authority rely on the explanations and experiences of this authority. Knowledge obtained in this way is assumed to be true without questioning its why and how (Gambrill, 1999). The teacher or the book as the authority in this context is an external source that is more knowledgeable. Therefore, "relating with an authority" was thought to be included in the category of relating.

When the students were asked how they found a pattern's rule during the first days of the teaching experiment, they simply stated that their teachers had taught them in this manner and were unable to put forward any logical explanation. Therefore, this knowledge can be considered as operational knowledge. The students who found patterns in the way that their teachers had taught them were not able to understand what it means 'to find the rule in a

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different way' when they were asked to do so. During the first two weeks of the teaching experiment, the students defended their knowledge using an authority figure. From then onwards, their knowledge shifted from being operational to contextual since they began questioning and thinking from different point of views.

In conjunction with relating and expressing similar situations, whether similarity/change is constant is investigated. This is referred to as searching in the generalization process. On the second day of the teaching experiment, Ali attempted to find a rule regarding the pattern by breaking the terms into pieces: "Each step has as many rows and columns as the number of steps. One row, one column in the first step; two rows, two lines in the second step. There are three points in each row and column, which makes six points in total. I multiplied the step number by six. Then, I excluded one point since I counted it twice (the point on the intersection of row and column). I also found the rule for the points I counted twice. It is 2n-1. I subtracted 2n-1 from 6n. Finally, I found 4n+1." If Ali had searched whether a relationship between the steps stays constant (for example, we added four to the first step and got the second step; we added four to the second step and get the third step...), these actions would be considered under the category of searching for the same relationship. However, Ali first determined the pieces that constitute the first step and then investigated whether the second and third steps are composed of these pieces too. Since it was investigated that whether the pieces are constant in other steps; that is to say, the focus is on the pieces, a new category was decided to be added to the taxonomy. The strategy Ali used to find this rule is defined by Rivera (2010) as "deconstruction generalization". Since pattern formation is a personal and constructive action, students should coordinate their comprehension and symbolic knowledge in order to make inferences about known and unknown steps of a pattern (Rivera, 2010, p. 298). In one study, it was reported that students divided a given shape into better known components and obtained a rule from the newly formed shape (Chua & Hoyles, 2011). Since this study investigates students' generalization processes based on the generalization taxonomy, it becomes necessary to adapt this strategy to the nature of the study. Therefore, it is appropriate to add this action performed by Ali and other students to the category of searching as "searching for the same piece".

Determining whether the relationship is constant is followed by the process of extending this relationship in a mathematically appropriate and accurate way. The expression of the determined relationship in a general form beyond the given situation is considered under the category of extending. The students' ways of thinking were determined through an analysis of the data obtained from the teaching experiment and organized as follows by adapting from the study conducted by Ellis (2007) and adding new categories as a result of the present study:

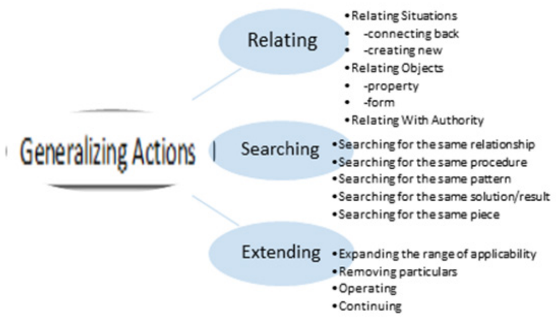

Figure 8. Students' ways of thinking regarding generalization process

As seen in the figure, students' ways of thinking are determined in the categories of relating objects and relating with an authority, searching the same piece, relation, pattern, procedure, solution/result; extending the range of applicability, extending by removing contextual details, operating, and by continuing.

In this study, students' ways of thinking about generalization were analysed according to the generalization taxonomy, on the basis of actor-oriented transfer. A review of the literature showed that the ways of thinking regarding generalization have been investigated based on different approaches. Barbosa (2011), for example, determined the strategies used by a group of 54 sixth-grade students by asking two questions requiring near and far generalizations to be made. Based on the results of the study, the way of thinking applied to generalization action was deemed to be recursive thinking, which means that the students solved the problems by using counting, whole-object, difference, explicit, guess and check strategies. When the data obtained in the present study is looked at from this perspective, it can be observed that Melike, for example, in the question about finding the E pattern's rule (Figure 3), used recursive reasoning, as she counted the number of squares in the first and second step and found the pattern rule by subtracting. In this way, she turned the shape pattern into a number pattern and found the solution by using the difference strategy. Recursive reasoning is quite widespread among students. Studies can be found in which students applied similar strategies by using recursive reasoning (Barbosa, 2011; Lannin, 2003; Orton & Orton, 1999; Stacey, 1989; Tanışlı &Yavuzsoy Köse, 2011; Zazkis & Lildejahl, 2002). In a study by Stacey (1989), a pattern question on finding the correct shape that followed another shape in order to discover the rule was presented to the students, and to solve it, they used a counting strategy, which was expressed in this case as "the number of lights increased by 4 in each shape". Moreover, in the same study, there was a question where students were to find the difference between terms; they found the solution based on the fact that there was a common difference for each term.

The practice of finding the rule governing a pattern by turning a shape pattern into a number pattern when a shape pattern is encountered is quite widespread. In the first days of the teaching experiment, it was observed that the students conducted their transactions by turning shape patterns into number patterns. Becker and Rivera (2006), in their study, reported that those who preferred a numerical approach in the generalization process conducted numerical transactions. The numerical approach can be described as turning a given shape pattern into a number pattern and using this number pattern to determine the rule (Becker & Rivera, 2005; Tanışlı & Yavuzsoy Köse, 2011). There are strategies for finding the solutions to number patterns. These strategies included i) comparing the terms of a given number sequence with another similar number sequence whose rules are already known; ii) putting each term in the number sequence into the place of the preceding term; iii) finding a formula by applying the differences method (Chua & Hoyles, 2011).

In the present study, on the question involving a shape pattern whose first three steps were given and a rule was to be applied (Figure 5), Gül first determined the number of squares in the given steps. Based on the increase in the squares in each step, Gül found a rule governing the number of squares to be found in the following steps, and therefore, she conducted visual thinking. Visual thinking is described as expressing verbally the way to complete a sequence, even if the shapes are not seen. Students who conduct visual thinking focus on the structural characteristics of the shape (Becker & Rivera, 2005, 2006). In questions requiring that the structural characteristics of the shape be considered, the focus can easily switch to the question of "how many?". Friel and Markworth, (2009) in their study, presented a pattern to students and asked the near and far steps of this pattern. For instance, when the smiley number in the 43rd step was asked, the students responded that in each of every three branches there were 43 smileys, while in the section where these branches merged there was an extra smiley. Students who employ visual thinking try to explain the relationship between shape and number of steps on the basis of the constant relationship in given shapes (Becker & Rivera, 2006).

The products that the students revealed as a result of their generalization actions are categorized as reflecting generalizations. The students identified a continuing phenomenon, the sameness of the situations, or a global rule. Further, they identified similar properties between two or more situations, objects, or representations. Nearly all of the tasks in the implemented teaching experiment contain at least one representation of verbal, algebra, table, or graph; in other words, the same situation is expressed in different ways. This is described as the expression of a similar object, or representation. Students might define a general rule between the relations as the product of generalization, a general pattern rule by noticing the pattern among relations, or general strategies/procedures regarding the solution. They can determine and express a mathematical rule as a general principle and define a set of objects as the product of generalization, even though they might not necessarily be mathematically accurate or complete rules. What is defined, however, is produced by the student's own point of view. In other words, the student might reveal a generalization product under the influence of his or her experience. If this is incorrect, the product revealed under the influence of prior knowledge is changed and modified. As a result, the ultimate product is a form of modified prior knowledge.

Recommendations

Students learn by relating new knowledge with existing knowledge. The more effective this relation is, the more learning is achieved. Therefore, topics should be taught by relating new knowledge with students' prior knowledge. Relating is the first step of generalization process, which students begin by searching for similarities between problem situations, objects, and other phenomena. Students should be encouraged to think in a way that allows these similarities to surface. Therefore, they should be equipped with the proper tools to do so. They should be provided to think about, question, and obtain knowledge they encountered in not only mathematics lessons but also daily life. Therefore, it should be ensured that they acquire the habit of thinking about why it is so. The people who can think and question, required by this age can only be raised in this way. Ellis (2007) developed the generalization taxonomy with eight-grade students on the topic of linear functions. This study was conducted with eight-grade students on the topics of pattern and relations, the analysis of variance, and equations. Through the analysis of different topics with the generalization taxonomy, new categories were added to the taxonomy. Further studies can be conducted with different participants on a different topic in order to contribute to the taxonomy.

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Fraction Learners: Assessing Understanding through Language Acquisition

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Abstract

This study applies the Mathematics Acquisition Framework (MAF) (Bossé, Ringler, Bayaga, Fountain, & Young, 2018) to investigate fifth- through seventh-grade students' comprehension of fractions and decimals and examines how students build understanding of mathematical principles and concepts regarding fractions and decimals. Based on case studies and discourse analysis, the results revealed students in different stages of the MAF with some students employing informal/social language in their mathematical communication and others using formal/academic language. Additionally, mathematically erroneous student communication was more positively interpreted through the lens of the MAF, which interpreted student errors, misunderstandings, and miscommunications as natural components to learning.

Keywords: Fractions, Language Acquisition, Mathematics Understanding, Middle Grades

Introduction

Over the decades, a generous body of literature has evolved in each of the distinct fields of mathematics learning (e.g., Kara & Incikabı, 2018; Biggs & Collis, 1982; Burger & Shaughnessy, 1986; Clements, Battista, & Sarama, 2001; Dienes,1960, 1971; Dienes & Golding, 1971; Van Hiele, 1986) and second language acquisition (SLA) (e.g., Chomsky, 1957, 1959, 1964; Krashen & Terrell, 1983; Vygotsky, 1978). Although much has developed in these fields regarding explaining student thinking and learning, the literature in these realms have, until quite recently, remained mostly distinct. Additionally, scant research has attempted to see how or whether these fields speak to, or complement, each other.

In response to the scant research addressing the possible intersection of these fields, Bossé, Ringler, Bayaga, Fountain, & Young (2018) determined that mathematics learning shares many similarities with SLA. They developed the Mathematics Acquisition Framework (MAF) which determined four stages of mathematics learning: receiving, replicating, negotiating meaning, and producing mathematics. The MAF was then applied to investigate the validity of the framework on elementary through high school mathematics learners (Bossé, Bayaga, Fountain, & Slate Young, (2017). This led to new avenues through which to analyze and understand student work in mathematics.

Literature Review

The background literature regarding employing the Mathematics Acquisition Framework (MAF) to investigate student understanding of fractions and fraction operations spans a number of fields including: fractions and decimals; primary and second language acquisition, mathematics learning, and mathematics acquisition.

Fraction and Decimal Learning

Numerous studies demonstrate that students struggle with both the understanding of, and the communication about, fractions and decimals (e.g., Jacob & Nieder, 2009; Kallai & Tzelgov, 2009; Meert, Grégoire, & Noël, 2009; Muzheve & Capraro, 2012; Opfer & DeVries, 2008; Schneider & Siegler, 2010) particularly in the dimensions of whole-number bias and number comparison paradigms (Iuculano & Butterworth, 2011; Kara & Incikabı, 2018). Thus far, the difficulties appear to be persistent and growing startlingly. For instance, while Opfer and DeVries (2008) suggest the challenge is with communication about fractions and decimals, Aliustaoğlu et al. (2018: 591) in exploring misconceptions of Fractions among elementary 6th graders found three main difficulties including; parts-whole relation, representation on number line and comparison as well as operations. Aliustaoğlu et al. (2018: 591) laments that "students have misconceptions in terms of parts-whole relation in fractions…," ibid also evidenced that "…representation of fractions on the number line…" is a source of difficulty as with "…comparison of fractions and operations in fractions."

From a mathematical perspective, these difficulties may be ascribed to leaners recognizing fractions by their whole-number constituent parts (numerators and denominators) rather than as a relationship among the parts (or as a quotient) and recognizing decimal numbers as a concatenation of digits in different place values and not a single, valued, number. However, some have recognized these misunderstandings to be more sourced in issues regarding student cognition rather than in the mathematics itself (e.g., Bartelet, Ansari, Vaessen, & Blomert, 2014; DeWolf, Rapp, Bassok, & Holyoak, 2014; Lyons, Price, Vaessen, Blomert, & Ansari1, 2014; Aliustaoğlu et al., 2018). A common theme arises from both the mathematical and cognitive perspectives: students strug-

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gle with number comparison paradigms in the context of fractions and decimals. In the context of fractions, since students find comparing components of two fractions (a numerator with a numerator, a numerator with a denominator, or a denominator with a denominator) – whether or not leading to an accurate understanding – as easier and quicker than calculating the actual value of the fractions, they opt for the former (Iuculano & Butterworth, 2011). While these studies agree that students struggle with both understanding and communicating about fractions and decimals, few have hypothesized a causal effect in either direction: poor understanding leading to poor communication or poor communication leading to poor understanding. Nevertheless, summarily, communication and understanding are interconnected.

Primary and Second Language Acquisition

Language acquisition is an innate, natural, predictable process occurring in normally developing children (Chomsky, 1957, 1959, 1964; Krashen & Terrell 1983; Vygotsky, 1978). Primary language acquisition occurs through social interaction sans explicit instruction. According to Innatists, an innate Universal Grammar applicable to the acquisition of any language guides the acquisition of grammatical rules (Chomsky, 1957; Lightbrown & Spada, 1999). Interactionists recognize that language acquisition occurs through processes of cognitive development and is tied to social development (Lightbrown & Spada, 1999; Vygotsky, 1978). The process of primary language acquisition has similarities with both Piaget's (1979) processes of assimilation and accommodation and Bruner's (1966) three modes of a child's innate cognitive development: Enactive, Iconic, and Symbolic. Notably, Piaget and Bruner, along with numerous other applied linguists (e.g., Bailey, Madden, & Krashen, 1974; Dulay & Burt, 1973, 1974) recognize sequential stages of development from concrete to abstract and from social to academic. Similarly, Krashen and Terrell (1983) propose sequential stages through which children learn a primary language: pre-production, early production, early speech emergence, early intermediate, intermediate, and advanced.

Second language acquisition (SLA) is the learning of a language in addition to one's native language and typically occurs in a structured learning environment. Krashen's Monitor Model (1977, 1982) recognizes a distinction between language learning and language acquisition and that in classroom contexts both can occur simultaneously. Krashen's model defines a silent period as when learners are more focused on understanding and processing language rather than producing it and comprehensible input as language students simultaneously understand and that is slightly beyond their current level of full understanding. Swain (1985) and Swain and Lapkin (1995) assert that comprehensible output or language production that causes students to recognize gaps in their own knowledge, is also necessary for acquisition. Selinker (1972, 1992) proposes the concept of interlanguage, the learner's idiosyncratic and constantly evolving development and articulation of unique codes in the process of SLA.

Through different nomenclature, many have discussed the process of SLA learners' personally and interpersonally negotiating meaning in the language being acquired and among others in the learning environment (Christiansen, 1997; Garfinkel, 1967; Krashen, 1977, 1982; Krashen & Terrell, 1983; Pica, 1996). Within SLA theory this negotiation of meaning is often restricted to the specific context of interpersonal communication and includes specific communicative strategies including confirmation checks, comprehension checks, and requests for clarification (Pica, 1987). In the framework in Bossé et al. (2018), this concept is extended to include both personal and interpersonal negotiation of meaning.

Cummins' (1979, 1984, 1991) theories principally concern SLA by English Language Learners (ELLs), native speakers of non-English languages integrated into English-language school environments, who are in the process of acquiring a second language for the dual purposes of social and academic applications. To this end Cummins proposes Basic Interpersonal Communication Skills (BICS) and Cognitive Academic Language Proficiency (CALP) regarding social and academic language applications and proficiency respectively. According to Cummins' Linguistic Interdependence Theory (a.k.a., Common Underlying Proficiency (CUP)), SLA leads to increased competence in both parent and second languages, as literacy skills and knowledge are transferable into any language (1979, 1984, 1991). Altogether, Cummins' framework argues a bidirectional sequencing from a social language to an academic language and from a lighter to a heavier cognitive load.

Based in the work of many (e.g., Bartelet et al., 2014; DeWolf et al., 2014; Iuculano & Butterworth, 2011; Jacob & Nieder, 2009; Kallai & Tzelgov, 2009; Lyons et al., 2014; Meert, Grégoire, & Noël, 2009; Opfer & DeVries, 2008; Schneider & Siegler, 2010), characteristics associated with student learning of fractions and decimals can be recognized in SLA constructs. For instance, some characteristics of fraction and decimal learning can be seen as:

- progressing from concrete to symbolic to abstract (compare with Bruner (1966));
- initiated by students being unable to communicate about and produce ideas about fractions and decimals to students producing simple, then more advanced ideas (compare with Krashen and Terrell (1983));
- beginning by students mostly silently learning from the teacher leading to students experiencing concepts slightly above their immediate ability to comprehend (compare with Krashen (1977, 1982)), grasping concepts regarding fractions and decimals for which they cannot adequately articulate (compare with Swain (1985) and Swain and Lapkin (1995)), and employing imprecise, vocabulary to articulate ideas commensurate with those with whom they are communicating;
- negotiating meaning of the fractions and decimals both personally and interpersonally (compare with Christiansen (1997), Krashen (1977, 1982), and Krashen and Terrell (1983) using confirmation checks, comprehension checks, and requests for clarification (compare with Pica (1987));
- developing from discussions that are informal, social, and cognitively undemanding to discussions that are formal, academic, and cognitively demanding (compare with Cummins (1979, 1984, 1991)).

Mathematics Learning

Van Hiele (1986) theorizes five levels of framework which are often utilized for mathematical learning with a specific focus on understanding geometry. While the five levels are not age dependent, they are sequential. Provided within the van Hiele model is a five-phase sequence through which students transition from any level to the following level; inquiry/information, directed orientation, explication, free orientation, and integration. The first of the five levels is visualization which is characterized by the ability to identify individual shapes, but cannot describe attributes of it. The second level termed as analysis, requires learners to prioritize the properties of a shape beyond the shape itself. The analysis level also requires learners to see the properties in isolation within the shape and not as a tool through which to compare shapes This second stage thus emphasizes the need to think in the context of connected properties rather than shapes. Abstraction which is the third level essentially requires learner to think in the context of connected properties rather than shapes. Abstraction is achieved by recognizing that certain combinations of these properties imply other ideas. The fourth level which is deduction requires the usage of deductive reasoning to create simple proofs and informally understand some aspects of non-Euclidean geometries. The last of the five levels is rigor. This stage requires some form of geometric understanding with some degree of sophistication and comparison of axiomatic systems.

Closely associated to Piaget's descriptions of assimilation and accommodation (1972), Dienes (1960, 1971) and Dienes and Golding (1971) proposed a six-stage Learning Cycle sequence describing how learners come to understand mathematics. The first three stages of Dienes' model include the stages of: free play, where early learners play with manipulatives or investigate ideas sans any predetermined rules; games, where the regularities discovered through free play become rules for games and further investigations; and searching for communalities, where common structures can be recognized across various games or ideas. These stages become cyclical and searching for communalities in one concept becomes play for a following concept.

The Learning Cycle is defined by representation, symbolization and formalization stages. While the representation requires learner to represent notions including games or ideas through some diagram or depiction, symbolization requires the learner to be able to condense representations. The symbolization stage however requires the need to turn notions into symbolic. The formalization requires learner to formalize findings into ordered structures similar to undefined terms, defined terms, axioms, and theorems.

Biggs and Collis' (1982) Structure of Observed Learning Outcomes (SOLO Taxonomy), also developed a sequence of levels in the learning of mathematics that students transition through. These levels or phases include: prestructural, where the learner does not understand issues within the task and attacks the problem inappropriately by oversimplifying a solution strategy; unistructural, where the learner focusses only on one aspect of the problem and does not recognize or utilize other aspects of the task; multistructural, where the learner addresses several relevant aspects of the task, but these aspects are disconnected and not synthesized; relational, where the learner coherently synthesizes relevant aspects into a conceptual whole; and extended abstract, where the learner abstracts and generalizes from the previous coherent whole into now topics of areas. The SOLO Taxonomy also recognizes intermediate stages between each sequential pair of stages.

Summarily, while there exist numerous conceptual agreements between the van Hiele, Dienes, and SOLO taxonomies, none may be more clearly recognized than that of the sequencing of levels. However, some have also recognized non-disjointedness between van Hiele levels (Burger & Shaughnessy, 1986; Clements, Battista, & Sarama, 2001; Fuys, Geddes, & Tischler, 1988; Usiskin, 1982 as cited in Fuys, 1985).

As was the case in respect to SLA, characteristics associated with some mathematical learning theories can be recognized in student learning of fractions and decimals. For instance, some characteristics of fraction and decimal learning can be seen as:

• Progressing from basic recognition of fractions and decimals to recognizing properties associated with such and to being able to use and apply fractions and decimals (compare with Van Hiele (1986));

• Initially gaining understanding of fractions and decimals through concrete manipulatives leading to observing patterns and being able to represent fractions and decimals through manipulatives and symbolically represent manipulative constructs as fractions and decimals (compare with Dienes (1960, 1971) and Dienes and Golding (1971));

• Progressing from undeveloped understanding of fractions and decimals and oversimplifying arithmetic associated with such (leading to incorrect algorithms) to focussing one some aspects of fractions and decimals to the exclusion of other aspects and to connecting fractions and decimals to the coherent whole under rational numbers (compare with Biggs and Collis (1982)).

Mathematic Acquisition

Combining the notions of mathematics learning and SLA, Bossé et al. (2018) propose a sequence of stages, the Mathematics Acquisition Framework (MAF), defining the learning of mathematics including: receiving mathematics, replicating mathematics, negotiating meaning, and producing mathematics. These stages are characterized through student behaviors depicted in Figure 1.

Notably, in addition to defining behavioral characteristics associated with stages of mathematical learning, the MAF demonstrates transitions in a number of characteristic dimensions including transitioning from social to academic language, cognitively undemanding to demanding, teacher centric to student centric, and listening to reading and speaking to writing previously suggested by authors such as of Selinker (1972, 1992) and Krashen and Terrell (1983) and Cummins (1979, 1984, 1991).

Objective of the Study

The objective of the current study is to investigate grades five through seven students' comprehension of fractions and decimals through the lens of the MAF. This had the intent of providing new dimensions of explanations regarding student comprehension, communication, and misunderstandings in the context of fraction and decimal learning. Implications from these findings are considered later in this paper.

Methodology

Following the literature review and objective of the study, the research methodology employed in this study are case studies and discourse analysis (Bogden & Biklen, 2003; Creswell, 2003; Miles & Huberman, 1994; Wodak, 2009; Wodak & Meyer, 2009). This study seeks to explore fifth, sixth, and seventh grades student understating of fractions and decimals through the lens of the Mathematics Acquisition Framework (MAF). In order to investigate this, five distinct scenarios of student-student or student-teacher interactions considering different contexts of fraction operations and understanding were observed. These included:

• Scenario 1: a sixth-grade student and his teacher consider division of fractions.

• Scenario 2: a fifth-grade student and her teacher consid-

Mathematics Acquisition Framework for the Learning of Mathematics

Characteristic Transitions	From		To
Language	Informal Social	⟶	Academic
Cognitive Level	Understanding	⟶	Demanding
Locus of Activity	Teacher	⟶	Student
Primary Mode of Communication	Listening	⟶ Reading and Speaking ⟶	Writng

Stages		Student Behaviors
Receiving		Students: listen; have limited comprehension and few responses; cannot distinguish valid and misleading information; recognize simple computations and solutions; use imprecise mathematical language.
Replicating		Students: comprehend contextualized information; respond to simple questions; talk and write about mathematical experiences; understand mathematical concepts disjointedly; use imprecise mathematical communication; demonstrate limited mathematical conceptual understanding; are focused on familiar heuristics; attempt to replicate what they observe; and read simple contextualized mathematics.
Negotiating Meaning	**Personal**	Students: have proficiency in communicating simple ideas and excellent comprehension; practice correctly communicating mathematics; apply mathematics to what they know; use multiple, albeit disconnected, representations; follow simple ideas but struggle to track novel ideas; engage both independently in mathematical investigations; apply mathematical concepts to their own interests; have a limited mathematical repertoire; see mathematical concepts and applications discretely; and become more involved in textbook readings and class notes.
	Inter-personal	Students: understand most mathematics,but struggle with intricacies; gain precision in communication, but have difficulty with novel topics; integrate mathematical ideas; discuss mathematical ideas to learn from others; uses more formal mathematical language; begin understanding concepts in different contexts; experiment with ideas provided by others; and cannot create novel mathematics.
Producing		Students: approach semi-professional fluency; explore multirepresentational math; use their knowledge to extend to novel ideas; become autodidactic; write mathematics properly; and interconnect mathematical concepts.

Figure 1. MAF Stages of Learning Mathematics [slightly edited from Bossé et al. (2018)].

er fractions and mixed numbers.

• Scenario 3: a group of sixth-grade students consider fraction simplification.

• Scenario 4: a group of seventh-grade students and their teacher consider connecting fractions and decimals.

• Scenario 5: a sixth-grade student and his teacher consider fractions and repeating and terminating decimals.

These scenarios were recorded in the students' and their respective teachers' regular classroom setting in one elementary school and two middle grades schools in the southeastern United States. These schools and teachers were selected for their convenience to the researcher; no other characteristics were considered. Videotaping occurred on days in which teachers were planning to cover various topics regarding fractions and decimals. Agreements were made to videotape any situations that arose during the class period.

To capture ideas within the data and to unpack meaning (Creswell, 2003), a systematic process of analysis was undertaken (Bogden & Biklen, 2003). Videotapes were transcribed and copies of student work were merged with each transcript. Transcripts were independently analyzed through discourse analysis (Wodak, 2009; Wodak & Meyer, 2009) to investigate student mathematical understanding, communication, and behaviors applicable to the MAF (Bossé, 2018). Common themes in the transcripts were characterized and labeled. Behaviors from the MAF were sought in the student transcripts for the stages of receiving, replicating, negotiating meaning, and producing mathematics. Codes were created regarding these MAF stages and additional codes were developed to observe characteristics regarding mathematics acquisition in respect to: a silent period, comprehensible input, comprehensible output, confirmation checks, comprehension checks, and requests for clarification. Coding structures were compared, differences reconciled, and refinements were made to initial codes. Check-coding (Miles & Huberman, 1994) was employed to allow researchers to reach consensus on the analysis of all transcripts. Narrative summaries were developed and validated by the researchers against transcripts and student work to describe findings in the transcripts in respect to the MAF.

Results with Initial Analyses

The results below are annotated transcripts from classroom situations in elementary and middle grades classrooms. Initial analysis follows each set of transcripts with particular attention given to division of fractions, fractions and mixed numbers, fraction simplification, connecting fractions and decimals, fractions and repeating and terminating decimals. These analyses consider student work, communication, and behavior through the perspective of the Mathematics Acquisition Framework (MAF).

Scenario 1: Division of fractions [In the following example, a sixth-grade student working through an example regarding division of fractions in a conversation with a teacher. The teacher has five years of teaching experience in this grade and a Masters Degree.]

Teacher: Please perform the operation.

Student: I think that I need to make an improper fraction first. Can be made into .

Teacher: How did you do that?

Student: 2 times 2 plus 1.

Teacher: How do you know that works?

Student: That's how we do it. So, now we have $\frac{5}{2} \div \frac{1}{6}$ *Then, we do keep-change-flip. We keep the first thing; change the division to a multiplication, and flip the last one. We do:* $\frac{5}{2} \div \frac{1}{6} = \frac{5}{2} \times \frac{6}{1}$.

Teacher: How do you know that works?

Student: That's just how we do it. It gives us an answer. $\frac{5}{2} \times \frac{6}{1} = \frac{30}{2} = 15$ *That's how you do them.*

That's what we were told.

Teacher: So, what is the answer?

Student: 15.

Teacher: 15 what?

Student: Just 15.

Teacher: So, $\frac{1}{6}$ *goes into fifteen times?*

Student: I guess.

Teacher: What does the 15 mean?

Student: I don't understand. It's 15.

Teacher: When you do division, you get an answer.

Student: But I really don't know where it comes from. 15 is bigger than my numbers. We aren't supposed to get bigger numbers when we divide. Maybe that's why we change the division to multiplication: so we can get bigger numbers.

When prompted to explain how to convert a number into an improper fraction, the student responds with "2 times 2 plus 1." However, the student is unable to explain why this is correct or anything more about the operation. When prompted to explain how he has arrived at the improper fraction 5/2, he is unable to go further than to say simply, "That's how we do it."

The student's discourse shows a limited conceptual understanding division by fractions. He focuses on a familiar heuristic (keep-change-flip) to recall how to proceed with the operation and is able to employ such to perform the operation. However, when probed by the teacher, the student is unable to demonstrate deeper understanding of what it means to divide fractions; his responses include "That's how we do it" and "It gives us an answer." Altogether, this may evidence the student's use of imprecise mathematical communication.

The student's answers continue to demonstrate a lack of understanding into the meaning of the operations he is performing. Arithmetic steps are performed because "That's still how you do them… That's what we were told." While the student arrives at a correct answer, when prompted to confirm the meaning of " $\frac{1}{6}$ goes into $2\frac{1}{2}$ fifteen times," the student replies with a noncommittal, "I guess."

When prompted directly to elaborate on what his answer means, he responds "I don't understand" and then "I really don't know where it comes from." Both answers may indicate that the student once more is relying on replicating operations that he has observed rather than working towards an understanding of what they mean. When asked whether or not division can result in a number larger than either of the operands, the student wonders if this may be "why we change the division to multiplication; so we can get bigger numbers." This exchange reveals limited conceptual understanding.

Analysis provides various clues that may indicate that the student is operating at a stage in which he is relying principally on memorized rules to replicate learned mathematical operations. The student states explicitly at several points that he is performing a given step or operation because this is the way in which he knows it should be done, but with no reflection on why this is the case and no demonstration of understanding the underlying concepts.

The student's behavior may present a number of characteristics from the descriptor of the MAF stages of receiving and replicating mathematics. From the stage of receiving mathematics, the student: demonstrates limited comprehension and provides few responses; cannot distinguish valid from misleading information; recognizes simple computations and solutions; and uses imprecise mathematical language. From the stage of replicating mathematics, the student: begins to comprehend contextualized information; responds to simple questions; talks and writes about mathematical experiences; understands mathematical concepts, albeit disjointedly; employs imprecise mathematical communication; demonstrates limited mathematical conceptual understanding; focuses on familiar heuristics; attempts to replicate what he observes from the teacher; and reads simple contextualized mathematics.

Most aspects attributable to the MAF stage of negotiating meaning are recognized in this student's work and behavior. Thus, by fulfilling behavioral numerous characteristics associated with receiving mathematics and fewer characteristics of replicating mathematics and almost none associated with negotiating meaning, this student is recognized as behaving and comprehending consistent with the stage of replicating mathematics.

Scenario 2: Fractions and Mixed Numbers [In this example, a fifth-grade student is working with a teacher on converting fractions to mixed numbers. The teacher has fifteen years of elementary school teaching experience and four years in this grade and a Masters Degree.]

Teacher: Convert $4\frac{2}{3}$ *to an improper fraction.*

Student: 3 times 4 is 12 plus 2 is 14. That gives $\frac{14}{3}$.

Teacher: I see what you did. Can you tell me why that works?

Student: That's what we were told to do.

Teacher: Ok. Please convert $-4\frac{2}{3}$ *to a mixed number.*

Student: 3 times -4 is -12 plus 2 is -10. That makes $\frac{-10}{3}$.

Teacher: Let's look at some numbers on the number line. Can you show me where -4 is on the number line? [Student correctly points at a tick mark appropriate for -4] Great. Now show me -5. [Student correctly points at a tick mark appropriate for -5] Terrific.

Can you point to where $-4\frac{1}{2}$ *is?*

[Student correctly points at a position centered between -4 and -5] Good. Where is $-4\frac{2}{3}$ *?*

[Student correctly points at a position between -4 and -5 and closer to -5] Great job. Let's add some tick marks to our number line. Let's put a tick mark at every $\frac{1}{3}$.

[Teacher constructs $\frac{1}{3}$ *tick marks from 0 to -5] Let's label these:* $-\frac{1}{3}, -\frac{2}{3}, -\frac{3}{3}$, *which is -1;* $-\frac{4}{3}, -\frac{5}{3}, -\frac{6}{3}$, *which is -2;* $-\frac{7}{3}, -\frac{8}{3}, -\frac{9}{3}$, *which is -3;* $-\frac{10}{3}, -\frac{11}{3}, \frac{12}{3}$, *which is -4; and* $-\frac{13}{3}, -\frac{14}{3}, -\frac{15}{3}$, *which is -5. Is everything right here?*

Student: I think so.

Teacher: You said that $-4\frac{2}{3}$ *is* $\frac{-10}{3}$. *[Pointing to the number line] But* $-4\frac{2}{3}$ *is way out here and* $\frac{-10}{3}$ *is right here.*

Student: Those aren't the same. Let me see... 3 times -4 is -12 plus 2 is -10. Isn't that right?

Teacher: Yes, 3 times -4 plus 2 is -10. But is that correct? You just told me that $-4\frac{2}{3}$ *is not at the same place as* $\frac{-10}{3}$.

Student: They should be. Maybe the number line is wrong. [Teacher and student review the number line and the student finds no errors, but again recognizes that the two values are at different positions]

Teacher: Is $-4\frac{2}{3}$ *the same as* $-4-\frac{2}{3}$ *or* $-4+\frac{2}{3}$?

Student: $-4+\frac{2}{3}$

Teacher: Why?

Student: Because $\frac{3}{2}$ *is* $\frac{1}{2}$ *more than 3. And* $-4\frac{2}{3}$ *is* $\frac{2}{3}$ *more than -4.*

Teacher: But $-4\frac{2}{3}$ *is* $\frac{2}{3}$ *more than -4 in what direction?*

Student: In that way. [Pointing toward negative values.]

Teacher: Ok. Point at -4. [Student complies.] Now go $\frac{2}{3}$ *further in that direction. [Student lands on* $-4\frac{2}{3}$.*] Great. So, that is* $-4\frac{2}{3}$ *and not* $\frac{-10}{3}$? *Does that change how you change* $-4\frac{2}{3}$ *into an improper fraction?*

Student: It's still 3 times -4 plus 2.

Teacher: Let's try something else. Is $-4\frac{2}{3}$ *the same as* $-\left(4\frac{2}{3}\right)$?

Student: What do you mean?

Teacher: Well, we know that -2 can be written as –(2). So, can $-4\frac{2}{3}$ *be written as* $-\left(4\frac{2}{3}\right)$?

Student: I don't know.

When prompted to explain how to convert a fraction in to a mixed number, the student can respond to a simple question and replicate what is observed to perform the operation correctly but cannot explain why her calculation works. She answers "That's what we were told to do."

The student's method of calculation fails when presented with a negative fraction and she is prompted to reconsider her thinking through the context a number line. However, with seemingly limited conceptual understanding and a disjointed understanding of mathematical concepts, she flounders when confronted with seemingly contradictory information.

The student is able to replicate what has been observed, "3 times -4 is -12 plus 2 is -10", but seems unable to connect this calculation to the evidence from the number line, even with significant prompting. She suggests that perhaps something is wrong with the number line rather than with her own calculation, again demonstrating limited conceptual understanding. The final portion of the transcript continues to bear out this dynamic, with the student sticking to her memorized formula. When pushed to question her reasoning, her comprehension breaks down and she equivocates: "What do you mean?", and finally "I don't know."

This student's behavior seems to evidence some of characteristics from the MAF stages of receiving mathematics, a greater number of characteristics from replicating mathematics (we will not repeat them again, here) and no characteristics from negotiating meaning. Thus, this student is positioned in the stage of replicating mathematics.

Scenario 3: Fraction simplification [In this example, a group of sixth grade students are discussing the meaning of fraction simplification.]

Teacher: [Pointing to a clock on a wall] What part of an hour is 12 minutes?

Student 1: Twelve sixtieths, or 12 over 60.

Student 2: We can write that as $\frac{12}{60}$.

Student 3: Then we can simplify $\frac{12}{60}$ *to* $\frac{1}{5}$. *[Students agree with the two answers]*

Student 4: But why do we want to change $\frac{12}{60}$ *to* $\frac{1}{5}$? *There are 60 minutes in one hour. Why change that?*

Student 3: But $\frac{12}{60}$ *is not simplified. The top and bottom have a common factor of 12. We can't leave it like that. We need to write it like* $\frac{1}{5}$.

Student 4: But if the two fractions are equal, does it matter how we write it?
Student 3: Yes, we are always supposed to simplify.

Student 1: But $\frac{12}{60}$ *makes more sense. 12 minutes out of 60. I know that* $\frac{12}{60}$ *is the same as* $\frac{1}{5}$, *but* $\frac{1}{5}$ *means 1 unit out of 5. So that one unit is a 12-minute unit. Whoever uses 12 minutes as one unit? That doesn't even make sense.* $\frac{12}{60}$ *is easier to understand when it comes to hours and minutes.*

Student 2: Then what about seconds? If we were looking at the same question, 'what part of an hour is 12 minutes?' and we were really thinking about seconds, we would need to write

$$\frac{12 \text{ minutes}}{1 \text{ hour}} = \frac{12 \text{ minutes}}{60 \text{ minutes}} = \frac{12 \text{ minutes}}{60 \text{ minutes}} \cdot \frac{\frac{60 \text{ seconds}}{1 \text{ minute}}}{\frac{60 \text{ seconds}}{1 \text{ minute}}} = \frac{720 \text{ secons}}{3600 \text{ seconds}} = \frac{720}{3600}$$

If we were looking at seconds, $\frac{720}{3600}$ *would make more sense than .*

Student 3: But $\frac{1}{5}$ *is still simpler. It has smaller numbers.*

Student 5: Wait a minute. $\frac{0.1}{0.5}$ *has smaller numbers than, but I wouldn't say this that was simpler.*

Student 4: [To the teacher] I'm confused. What do YOU want us to do?

This student discourse seemingly demonstrates students communicating with each other in order to negotiate the meaning of the mathematics. In addition to considering the meaning of the representation and applying an interpretation of the representation to the problem, the fractional representation is altered in order consider additional ideas. These students are comfortable moving beyond the simplest answer to discuss mathematical ideas and experiment with ideas from other students. Similar discourse continues as the students move beyond the original context of telling time to discuss the representation of fractions more globally through the employment of more formal (academic) mathematical language. These students are beginning to understand the concept of fractions in different contexts and are gaining precision in their mathematical communication. Beyond simply discussing the meaning of the fraction in question, the students collaboratively experiment with novel ideas.

In respect to the MAF, these students have seemingly surpassed receiving and replicating mathematics. They are no longer simply listening to the teacher or trying to mimic what they see. Student behaviors seem more in the realm of negotiating meaning. For instance, evidence exists of these students: possessing proficiency in communicating simple ideas with increased precision (formal, academic language) as they debate the meaning of simplification; demonstrating excellent comprehension, albeit struggling with particular conceptual intricacies and novel topics (e.g., as they multiply by a compound fraction equal to one); integrating mathematical concepts and applying mathematics to what they know and their own interests (e.g., as they apply fractions to time); and considering multiple mathematical representations (e.g., as they consider a fraction with a decimal numerator and denominator). Additionally, the students seem to be valuing communications with others as a significant experience within learning. While these students exhibit behavioral traits representing the stage of negotiating meaning, they do not seem to demonstrate behaviors commensurate with the stage of producing mathematics.

Scenario 4: Connecting fractions and decimals [In this example, a group of seventh grade students working with a teacher on concepts of fractions. The teacher has two years of experience in this grade and five more year of experience teaching sixth grade.]

Teacher: Find a fraction halfway between $\frac{1}{3}$ *and* $\frac{1}{4}$.

Student 1: It is 0.29.
Student 2: That is not a fraction.

Student 1: No problem, I'll just make that $\frac{29}{100}$. *I like working with decimals more than fractions. So, I wrote* $\frac{1}{3}$ *as 0.33 and then* $\frac{1}{4}$ *as 0.25. Halfway between the two decimals is 0.29.*

Student 2: I thought about the problem as doing averages and got $\frac{7}{24}$ *for my answer. I added* $\frac{1}{3}$ *and* $\frac{1}{4}$ *by finding the common denominator of 12. So, I really added* $\frac{4}{12}+\frac{3}{12}$. *That gave me* $\frac{7}{12}$ *which I divided by 2 to get* $\frac{7}{24}$.

Student 3: I started out the same way, but I got something different for an answer. Since the fractions had a common denominator, I found the fraction halfway between. So, $\frac{1}{3}=\frac{4}{12}$ *and* $\frac{1}{4}=\frac{3}{12}$.
Since 12 is in both fractions, I just found the number halfway between 4 and 3. It's either 3.5 or $3\frac{1}{2}$. *So, my answer is* $\frac{3\frac{1}{2}}{12}$.

Student 4: I don't think you are supposed to have a fraction within a fraction.

Student 5: I bet all three answers are really the same. I think they are all correct!

Student 2: The answers just don't look the same to me. Could we put them all in the same form to check?

Student 5: I can see that $\frac{7}{24}$ *and* $\frac{3\frac{1}{2}}{12}$ *are the same. Because the 12 is half of 24 and* $3\frac{1}{2}$ *is half of 7. They are in the same ratio.*

Teacher: Excellent! Now, if the last two answers are equivalent, how could [Student 1] check to see if they are equivalent to his answer?

Student 1: We could convert the fractions to a decimal! I would – it is much easier. Since we already know that both fractions are equal to $\frac{7}{24}$, *convert it to a decimal by dividing 7 by 24.*

Student 5: That will work.

Student 4: But $\frac{7}{24}$ *is a repeating decimal and it doesn't equal 0.29. If is right, then [Student 1] did something wrong.*

Teacher: But what if [Student 1] is right?

Student 5: I think the $\frac{7}{24}$ *is right because it was equal to [Student 3's] answer. And it seemed like everything they did was right.*

Teacher: That's a good enough theory. But can you find anything wrong with [Student 1's] reasoning?

Student 1: Would it make a difference if I rounded $\frac{1}{3}$ *when I converted it to a decimal?*

Teacher: What do you think? [Asking the class] Did rounding make a difference? Could [Student 1] work with the decimals without rounding? Think about this tonight and if you have further ideas, we will explore them tomorrow.

In this exchange, the students consider and experiment with ideas proposed by others. Even when occasionally incorrect, the students' language is increasingly academic. The context of their communication is becoming cognitively demanding and the learning experience more student centric. Student communication shifts from verbal to symbolic, accentuated by more detailed verbal explanations. Comprehensible input takes the form of students not fully understanding the unusual explanations of other students and comprehensible output can be recognized through students being unable to explain completely their reasoning. At an increased pace, instances can be recognized where students are attempting to confirm their understanding, check their own comprehension, and seek clarification of ideas and understanding.

In respect to the Math Acquisition Framework, while the students' communication employs mathematical representations and recognize the power and value of each, the representations remain somewhat disconnected. For instance, although Student 1 claims to be able to convert fractions to decimals, he focusses more on decimals representations, gets an incorrect answer, and does not use his knowledge to check why the answer is incorrect. As the conceptual understanding of most of the students still reveals some gaps and misconceptions, great strides are being made within the groups to unify ideas and develop common understanding. For instance, Student 1 converts a fraction problem into a decimal problem, but converts 1/3 to 0.33. This is a round off error that is not caught by the other students. However, the students are together moving to the notion of calculating in their own form , even when it results in a fraction with a decimal or a mixed number in the numerator. Their focus is on communicating mathematics in an increasingly symbolic manner, employing mathematical representations to the best of their ability. The students follow most ideas they encounter, but still struggle with some ill-formed ideas posed by some of their fellow students. For instance, although they arrive at two different answers – one incorrect one in decimal form and a number of equivalent forms of a fractional answer, they struggle to reconcile the two different answers. Notably, the students in this scenario are now both communicating together and relying on the ideas of others to form and confirm their own understanding. The form of negotiating meaning is now interpersonal. The students do not rely simply on their own understanding; they are attempting to negotiate their own ideas with the ideas of the other students.

Scenario 5: Fractions and repeating and terminating decimals [In this example, a sixth-grade student working with a teacher on a notion regarding fractions and terminating and repeating fractions. The teacher has seven years teaching experience, all in this grade.]

Student: I think that I can tell if a fraction is a repeating or terminating decimal without doing the division.

Teacher: How?

Student. I started by looking at different numbers like 2, 3, 4, 5, 6, 7, 8, 9, and 10. I noticed that 2 terminated, 3 repeated, 4 terminated, 5 terminated, 6 repeated, 7 repeated, 8 terminated, 9 repeated, and 10 terminated?
Teacher: What do you mean that these numbers terminated or repeated? They are all just integers.

Student: No, I mean when they are in the denominator. Fractions with those denominators terminate or repeat.
Teacher: Always?

Student: I think so.

Teacher: What about $\frac{3}{6}$*? That terminates.*

Student: I know! I mean when the numerator is 1. Like $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$, $\frac{1}{5}$, $\frac{1}{6}$

Teacher: But, does it have to be 1? If $\frac{1}{3}$ *terminates,* $\frac{2}{3}$ *doesn't also?*

Student: Ok. You're trying to trick me. It's not what the numerator is. It's actually if the numerator and denominator are relatively prime. So, it can be any number in the numerator, so long as they are relatively prime. That means that 1 will always work in the numerator if the denominator is anything other than 1.
Teacher: So, how can you tell if the fraction will produce a terminating or repeating decimal?

Student: I factor the denominators. If the factors in the denominator are only 2s and 5s or 2s or 5s – not quite sure how to say it – then the decimal will terminate. I think that you can look at this and even tell how many digits are in the decimal when it terminates. But, I'm still working on that idea.

Teacher: So, is it "2s and 5s" or "2s or 5s"?

Student: I knew that you were going to ask me that! Because I can have a denominator of 2, 4, and 8 terminate and 5 and 25 terminate, then I guess that I don't need both. So, I think it is "or". But I can have both. Like 10 is 2 and 5; 40 is 2 and 2 and 2 and 5; 50 is 2 and 5 and 5; and 100 is 2 and 2 and 5 and 5.

Teacher: And what about denominators like 3, 6, 15, and 35?

Student: If you factor those, you get 1×3, 2×3, 3×5, and 5×7. In each one you get factors other than 2s and 5s.

Teacher: But 6 has a factor of 2?

Student: Yes, but it has a factor that is neither 2 nor 5.

Teacher: What about a denominator of 800?

Student: Um. That is 800 = 8×100 = 8×4×25 = 8×2×2×5×5 = 2×2×2×2×2×5×5. All 2s or 5s. that will terminate. As long as the numerator is relatively prime to 800.

Teacher: Where did you find this idea?

Student: I didn't find it. I just played with numbers until I got it.

Teacher: Do you know why it works?

Student: I'm not sure yet, but I think that it has to do with those being the factors of 10.

The student's language is gaining mathematical fluency. He uses terms such as numerator, denominator, factors and relatively prime. He rarely employs social language in his mathematical discussion and is becoming fluent in his academic language, communicating in a highly symbolic form. His initial hypothesis was born from investigating fractional and decimal form of rational numbers and interconnecting these ideas, thus denoting an ability to comfortably switch between representations. In developing his own theory regarding terminating and repeating fractions, he demonstrates that he is autodidactic and enjoys considering novel mathematical ideas and does not steer away from cognitively demanding tasks.

In respect to the MAF, this student is producing mathematics that is novel to him. Although his ideas are incomplete, his development of ideas is beyond what he has encountered in the class and demonstrates that he is in a stage of learning beyond most of his peers. His relationship with mathematics positive and somewhat recreational. Altogether, it seems that he is in the MAF state of producing mathematics.

Discussions and Implications

Recall that the present research sought to apply the MAF to investigate grades five through seve7 students' understanding of fractions and decimals. We examined how students transitioned and built understanding of principles and concepts through MAF. Following the methodology, we explored the of our findings to the background literature, we pay attention to MAF Expanse and appropriate curriculum. Some attention was devoted to growth through misunderstandings by which we mean locus of activity and mode of communication.

MAF Expanse and Appropriate Curriculum

The preceding transcripts and analyses demonstrate that students may be at very different stages in the MAF and the learning of mathematics, and this need not be a product of chronological development. Indeed, all of the students in this study were from grades five through seven;

and yet, the entire spectrum of the MAF is recognized. This is consistent with some aspects of SLA as seen in the work of Selinker (1972, 1992), Krashen and Terrell (1983), and Cummins (1979, 1984, 1991) as demonstrated through the five research scenarios:

Scenario 1. While his informal mathematical articulations demonstrate his use of social language and that he has not yet moved to more academic language (Cummins, 1979, 1984, 1991), he has clearly passed beyond the silent period (Krashen, 1977, 1982). His task is one of simple, cognitively undemanding calculation and the mathematics problem is teacher generated and the learning is teacher centric (Cummins, 1979, 1984, 1991). The student is satisfied with repeating – to the best of his ability – what he has heard in the classroom. The student remains primarily a listener and speaks to repeat what he has previously heard (Krashen, 1977, 1982). The student experiences comprehensible input (Krashen, 1977, 1982) such as why the operations work as they do and comprehensive output (Swain, 1985; Swain & Lapkin ,1995) such as being able to describe that the answer of 15 meant 15 of the divisors.

Scenario 2. This student uses informal (social) mathematical language and falls short of employing formal academic language and her task remains one of a simple, teacher generated (teacher centric), and cognitively undemanding calculation (Cummins, 1979, 1984, 1991). The student is primarily interested in repeating (as correctly as understood) what she has heard in the classroom (Krashen, 1977, 1982). She experiences comprehensible input regarding whether can be written as $-\left(4\frac{2}{3}\right)$ (Krashen, 1977, 1982) and comprehensible output as she has some understanding but cannot explain her reasoning (Swain, 1985; Swain & Lapkin, 1995). She employs an interlanguage in trying to explain whether $-4\frac{2}{3}=-4+\left(-\frac{2}{3}\right)$ (Selinker, 1972, 1992). She does not yet appear to be at the stage of negotiating meaning; we do not yet see occurrences of confirmation checks, comprehension checks, and requests for clarification (Pica, 1987).

Scenario 3. The students have progressed from using informal, social language to formal academic language as their mathematical communication becomes more symbolic and written rather than singularly verbal and they are experimenting with increasingly cognitively demanding tasks, as they are investigating and generating definitions for fractions in simplified form and are not simply performing calculations (Cummins, 1979, 1984, 1991). The learning experience is becoming increasingly student centric (Cummins, 1979, 1984, 1991). While there remain moments of comprehensible input and output, the students' communication contains interlanguage as they talk about the "top" and "bottom" of the fraction and discuss the meaning of "simplified" (Krashen 1977, 1982; Selinker, 1972, 1992; Swain, 1985; Swain & Lapkin, 1995). In the proicess of negotiating meaning, the students regularly employ confirmation checks, comprehension checks, and requests for clarification as they navigate concepts novel to themselves and to the others (Pica, 1987).

Scenario 4. The students' language is increasingly academic in nature and the context of their communication is becoming cognitively demanding and the learning experience more student centric (Cummins, 1979, 1984, 1991). Comprehensible input takes the form of students not fully understanding the unusual explanations of other students and comprehensible output can be recognized through students being unable to explain completely their reasoning (Krashen, 1977, 1982; Swain, 1985; Swain & Lapkin, 1995). Students have increased instances of students attempting to confirm their understanding, checking their own comprehension, and seeking clarification of ideas and understanding (Pica, 1987). The students are both communicating together and relying on the ideas of others to form and confirm their own understanding (Christiansen, 1997; Garfinkel, 1967; Krashen, 1977, 1982; Krashen & Terrell, 1983; Pica, 1996).

*Scenario 5.*The student's language is increasingly academic in nature and he rarely employs social language in his mathematical discussion and he does not steer away from cognitively demanding tasks (Cummins, 1979, 1984, 1991).

Summary of Scenarios

The five scenarios provide evidence of students in different, and ascending sequential, stages in the MAF. Through this progress, evidence exists of transitioning from: social to academic language; cognitively undemanding to demanding; teacher centric to student centric; and listening to reading and speaking to writing. Although beyond the scope of this immediate study, it might be the case that students even in one seemingly homogeneous classroom may be at different stages in their learning. Therefore, even within a narrowly defined population, it is possible that some students are at one end of various spectra and others are at different ends. For instance, one student may be; focusing on listening; expecting learning to be centered on the teacher; using informal, social language; and struggling with cognitively undemanding tasks. Simultaneously, another student may be; focusing on writing mathematical ideas; expecting learning to either be through group interaction or be autodidactic; using formal, academic language; and engaging with cognitively demanding tasks as a growth through misunderstandings.

Growth Through Misunderstandings

The recognition of mathematical errors and misunderstandings within student work take on different meanings in light of the MAF. Rather than simply considering student mathematical mistakes or misunderstandings as such, dimensions defined in the MAF make mathematical misunderstandings more contextualized in the learning process. Rather than faulty understanding, it can be recognized that students often experience: comprehensible input as they interact with information slightly beyond their understanding (Aliustaoğlu et al., 2018; Krashen, 1977, 1982; Krashen and Terrell, 1983); comprehensible output as they struggle to articulate what they know (Krashen, 1977, 1982; Krashen and Terrell, 1983); and interlanguage as they employ their incompletely formulated language and vocabulary (Selinker, 1972, 1992) to communicate their understanding. Indeed, these experiences and characterizations are quite idiosyncratic. Therefore, mathematical miscommunications and incomplete ideas can be recognized as natural aspects of learning rather than as mathematical misunderstandings.

The implication to this is to recognize mathematical errors and misunderstandings – particularly through student verbal articulation – as natural and positive within the process of learning. The idea that linguistic errors occur naturally on the path to acquiring language is well-studied and well-developed in the literature on both first and second language acquisition (Selinker, 1972, 1992), and given the connections made here between learning language and learning math, a parallel would not be unexpected. Quite possibly, then, student mathematical errors should be held as windows into student learning and not too quickly corrected. If we extend the parallel with SLA, the main goal would be to prevent these naturally occurring errors from becoming fossilized or internalized incorrectly by the learner as they move forward in the process of acquisition.

Locus of Activity

The transcripts in this study demonstrate cases in each of the stages of the MAF. In part, the cognitive level of the mathematics investigated and the locus of instruction define these stages. However, both of these dimensions may be more driven by the learner than by the classroom teacher. For instance, the students in this study in receiving and replicating mathematics consider the mathematics presented by the teacher at a low cognitive level. This does not mean that the teacher presents the mathematics at a low level; rather, the students can only consider whatever mathematics is presented at a low level. Conversely, the student in this study in the stage producing mathematics seems to consider more cognitively demanding mathematical concepts than what is presented by the teacher. Additionally, whether or not students desire to be the locus of instructional activity in the classroom, it seems that the students in this study in receiving and replicating mathematics would have a great deal of difficulty in this role and might find it both uncomfortable and inefficient in leaning in this role. Conversely, whether or not the teacher seeks to remain as the locus of instructional activity, the students in negotiating meaning and producing mathematics may seek for ways around the teacher in order to themselves become the center of their own learning.

This may raise a few implications. It is likely that the mathematical sophistication of a task is dependent on how cognitively demanding the students address the task. Students in lower stages may address all tasks at a low cognitive level and students in higher stages may begin from and embellish teacher-given tasks to being more cognitively demanding. On a parallel vein, it may not matter who the teacher determines to be the locus of activity. If the teacher endeavours to create a learner-centric instructional environment and the students are in the lowest stages of MAF, the environment may not affect learning. Conversely, if a teacher seeks to create a teacher-centric instructional environment for students in the highest stages of MAF, it is likely that these students will find opportunities to openly discuss the mathematics at hand, and thereby learn, or learn autodidactically. Thus, it may be that neither the mathematical content or the task nor the learning activity or the learning environment may affect either the cognitive load or the locus of activity that the students actually experience.

Mode of Communication

As defined in the MAF, the primary mode of communication in the states of learning transitions along the path:

listening → speaking / reading → reading / speaking → writing

As seen in Scenarios 1 and 2, the students rely on listening to the teacher and attempting to replicate what they previously heard. At the other extreme, in Scenario 5, the student communicates the precision of his ideas in written form. In Scenarios 3 and 4, we recognize students employing different degrees of speaking and reading in order to come to understanding and communicate ideas.

Some implications to this may be that, although our goal in education may be to get students to write mathematics, we may be asking too much, too early of many students – particularly when students are in early MAF stages. It may be that the introduction of writing assignments should only come after students are comfortable verbally communicating mathematical ideas.

While this study answers some questions, it may in turn raise many more. For instance, Van Hiele (1986) opines that, in order for a student to transition from any of the five stages (visualization; analysis; abstraction; deduction; and rigor) of the Van Hiele Model of Geometric Understanding to the subsequent stage, the student must experience five phases of attainment (information or inquiry; guided or directed orientation; explicitation; free orientation; and integration). Unfortunately, it is not yet known how to assist – or possibly accelerate – a student through to higher stages in the MAF. It might be as easy as treating a student in one stage as if he or she was in the subsequent stage. This is yet unknown.

Further Implication

The implications of this may be summed up in a seemingly trite phrase: one size does not fit all. With students at various stages of learning in the MAF and each stage having its particular nuances, it becomes apparent that no one size task or curriculum may fit all student needs. Nor does either group work (requiring communicative interaction), writing assignments (reflections or journaling), or demanding fully developed proper mathematics vocabulary – as appropriate as that may seem among reformed curricular recommendations – necessarily fit for students in the earlier stages. Thus, teachers must assess where students are in the MAF in order to provide the students developmentally appropriate learning activities.

Conclusions

Students, even among those from only a limited number of classes and even under the same teacher, can be at different mathematical learning stages in respect to the MAF. Some students employ informal/social language in their mathematical communication while others develop and use academic language. Some students are ready for, and thrive on, cognitively demanding tasks, while others are more comfortable with cognitively undemanding tasks. Some students are prepared for a teacher-centric learning environment, while others learn through student-centric environments and tasks. And some students learn through listening, others through reading and speaking, and still others through writing. Altogether, the variety of learning which occurs through transitioning through the MAF is significant. This may mean that teaching strategies should differ according to student learning needs.

The application of the MAF allows for more a positive interpretation of student errors, misunderstandings, and miscommunications. Rather than perceiving these in the negative, they can be seen as natural components to learning. This helps teachers and students experience a positive learning environment and may, in the end, address issues regarding math phobia.

The changing from teacher-centric to student-centric learning experiences may have far-reaching ramifications on future classrooms. As students move through the MAF, it is not the teacher who alters his or her teaching style; students naturally make this progression – or at least seek out these experiences. Teachers need only to teach to the needs of the students and this shift in locus of activity will occur naturally.

It is hoped that this investigation will inspire others to consider the MAF and student learning in greater detail. The authors hope that soon others will discover pedagogical applications that will assist students to both address student needs at every stage of the MAF and assist them to move through the MAF to higher stages of learning.

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Longitudinal Impacts of Home Computer Use on Primary School Children's Reading and Mathematics Achievement

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Abstract

This study investigates the impact of children's Home Computer Use (HCU), both educational and recreational, on their achievement in Reading and Mathematics during primary school. The data are taken from a longitudinal study in England called Effective Provision of Preschool, Primary and Secondary Education (EPPSE). Hierarchical linear regressions were employed to investigate the main (direct) effects, and path analyses were applied to study the mediation (indirect) effects of HCU on pupils' school achievement. The main effect models indicated that HCU has very little 'extra' impact on children's school results over and beyond their prior achievement and demographic background. By contrast, results from path analyses showed a statistically significant mediation effect, through the home learning environment and self-regulation, on children's Reading and Mathematics scores. The implications of the findings for policy and practice are also discussed.

Keywords: Elementary (Primary) Education, Home Computer Use, School Achievement, Home Learning Environment

Introduction

The spread of computers and new technologies have resulted in an information technology revolution that would overturn everyone's life and work (Lean, 2016). Unlike the use of Information and Communication Technologies (ICTs) in schools, the home use of digital technologies by children and its effects have remained an under-researched area (Wang & Minghao, 2012). This is striking since nowadays (informal) learning occurs not only at schools but also out-of-school at home (see Noroozi et al., 2012, 2016; Gu & Xu, 2018). This gives a false picture of the extent of ownership and use of computers by children at home – which will soon reach saturation point in England, with one computer per child at home (McPake, Ploman & Stephen, 2013) compared to a lower rate of availability of computers and their limited use in schools. This is where the ICT research community needs to think about the neglected 'secret garden' (Wellington, 2001), in other words, 'home is where the hardware is' (Facer, Furlong, Furlong & Sutherland, 2001) by examining what children do on home computers.

Despite this research neglect, policy on the subject is quite progressive. The British government has raised its commitment to ICT deployment in education through targeting national home access to ICT and addressing ICT-based parental engagement within new parenting policies. However, studies on Home Computer Use (HCU) in the UK are mainly based on a small number of case studies and mostly focus on the anecdotal evidence of children, parents or teachers, rather than applying clinical measurements to determine their impact on children. Valentine, Marsh and Pattie (2005) noted that there has been a rapid growth in home ownership of computers and internet access, but evidence of the effect of home use of ICT on educational performance is limited. Apart from the role of computer use, ICT research is also frequently criticized on other grounds. These include small sample sizes, cross-sectional rather than longitudinal studies, use of merely descriptive statistics or limited bivariate models (Gardner & Galanouli, 2004), and focusing on technology rather than its effects on learners (Underwood, 2004). The present study aims to address some of these limitations by drawing upon data from an ongoing large scale research project in England which has collected data not only on home computing activities of children and their parents, but also on other aspects of parenting and the Home Learning Environment (HLE) which have important relationship with the home computing environment. Therefore, the main objective of this paper is to investigate the relationship between HCU and children's school achievement while monitoring inputs coming from their individual, family and HLE circumstances.

Theoretical Background

What do children do and learn on home computers?

Learning is an inseparable part of every moment of children's lives. They learn through play, talking with adults, peers and teachers, watching TV, using home computers etc. Each of these learning episodes is a function of the specific activity a child is engaged in, the social and cultural surrounding of the learning activity, and the child's personal interests, motivation and capacity to achieve a particular learning objective (Facer, Furlong, Furlong & Sutherland, 2003). Therefore, what they learn through home PCs should be studied within an interwoven network of potential activities which children might perform on home computers, the home social and cultural resources as a context for learning, the child's personal circumstances and interests, and the availability of home computers and the Internet.

Studies show that children perform a range of activities on home computers depending on an array of social, psychological and economic factors (Livingstone & Bober, 2004). A study on the range of activities that primary school children (focusing on Y3-Y6 pupils) engage in on home computers in

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the UK showed that children used 18 main types of the Internet applications at home (Selwyn, Potter & Cranmer, 2009). As expected, playing games came at the top (80%) followed by making pictures (43%), using a program on a CD (41%), writing things (38%), using digital cameras (28%), while least frequent activities were computer-based applications using spreadsheets and databases (10%).

Therefore, it is hard to cover all these different activities under an umbrella term such as ICT, and then try to link them to children's educational outcomes. Borzekowski and Robinson (2005), Wenglinsky (1998) and O'Dwyer, Russell, Bebell and Tucker-Seeley (2005) investigated the relationship between children's Reading scores and their particular computing activities, such as the frequency of computer use to send/receive emails, to edit compositions, to find information, and to create Powerpoint presentations. The drawback of this approach is the fact that these seemingly different activities are not entirely distinct from each other; indeed they might all take place simultaneously. Therefore, in order to give a bigger and more exact picture of children's home computing activities and to be able to generalise the findings across all children, the present study, following other authors (e.g. O'Dwyer et al. 2005, Valentine et al. 2005, Wittwer & Senkbeil, 2008), loosely categorised children's computing activities into two broad classes: educational and recreational use. Educational use mostly refers to school- related activities such as doing homework, searching for information for school purposes, writing essays, using presentation programs etc. Recreational use broadly covers any other activities not related to school work, such as playing games and social networking. Although there are obviously many areas of overlap between the two types of HCU, close examination of children's activities on home computers requires some sort of arbitrary boundaries. This approach is adopted in both large-scale studies and qualitative case studies (Facer et al. 2003).

HCU and school achievement

Here we focus on two areas of school achievement in primary education:

HCU and literacy level. A review of literature shows that different uses of home computers have contributed to some improvement in literacy achievement, i.e. Reading, Writing and the overall English test but the results are inconsistent (see Durkin & Conti-Ramsden, 2012; Vigdor, Ladd, & Martinez, 2014). Valentine et al. (2005) found no significant relationship between all home ICT use measurements for educational purposes with children's achievement in Reading in Y2 and English in Y6 as measured by national assessments. However, they did find a significant relationship between the use of the Internet and educational websites with achievement for older groups in Year 11. This relationship was found after controlling for children's baseline measurements and background circumstances. By contrast, Harrison, Comber, Fisher, Haw et al. (2002) reported a significant positive relationship between ICT use and national tests for English in Y6. However, the ICT measurements in these two studies were different, so the results are not comparable. The former study used various types of activities on only home computers, while the latter used an aggregate of ICT use at home, during lessons, and at school outside lesson times. Therefore, one cannot relate such significant relationships to any of those three scenarios.

In order to overcome this problem, O'Dwyer et al (2005) investigated children's school and home use of ICT separately; and through carrying out a multi-level statistical analysis they found that 4th graders' educational use of home computers (e.g. writing essays and searching the Internet for school-work) did not affect their performance in the English standardized test or its sub- scales in Reading and Writing. By contrast, after a 16-month trial, Jackson, Von Eye, Blocca, Barbatsis, Zhao and Fitzgerald (2006) found that children aged 10-18 who used the Internet at home obtained higher scores in standardized tests for Reading comprehension and Reading generally, after the effects of race, gender and age were partialled out. They did not control each family's socio-economic status because participant families were all from disadvantaged groups (primarily African American and single-parent households) whose annual income was $15,000 or less. However, recreational use of home computers (e.g. playing games, searching the Internet for fun, chatting, instant messaging) was shown to be adversely and significantly related to children's achievement. O'Dwyer et al. (2005) found a negative relationship between the 4th graders' score in English Language and Arts with their HCU for recreational purposes. Similar findings were echoed by Valentine et al. (2005) for Y11's achievement in English and the levels of HCU for game playing.

HCU and Numeracy achievement. Similarly to literacy outcome measurements, the findings from past studies about the relationship between use of home computers and any improvement in Mathematics are sketchy. Not many studies investigated this relationship for younger learners in Key Stage1 and those that did include this age -group did not find a significant relationship between their level of HCU and raised scores in Y2 national assessment of Mathematics (Valentine et al., 2005). For older children in Year 4, still no significant relationship was found (O'Dwyer et al., 2008). But specific uses of computers in school (e.g. the use of simulation and higher order thinking software), as opposed to more general use, was shown to have a significant correlation with raised scores in Mathematics (Wenlinsky, 1998). Similar findings (i.e. non-significant relationship over and beyond other demographic circumstances) were mirrored in the longitudinal HomeNetToo project (Jackson, von Eye et al., 2006). For older children in Year6, Valentine et al. (2005) found a positive though weak significant relationship between the frequencies of HCU for school work and raised scores at the end of the Key Stage2 Mathematics assessment. However, in another study done by Harrison and colleagues (2002), although the above-mentioned relationship was positive, it was not statistically significant. Similar weak (Wittwer & Senkbeil, 2008; Angrist & Lavy, 2002) and even negative (Fuchs & Woessmann, 2005) relationship were reported in the literature on secondary school pupils' level of HCU and their school achievement in Mathematics.

In summary, the evidence concerning the effects of HCU on children's school achievement is quite mixed. This can be explained by the nature of the issue under investigation and the methodological limitations of past studies. The interplay of different factors influencing children's learning outcomes – of which the use of technology is only one small element – will produce mixed results (McFarlane, Harrison, Somekh, Scrimshaw, Harrison & Lewin, 2000; COX, Abbott, Webb, Blakeley, Beauchamp & Rhodes, 2003; Subrahmanyam, Kraut, Greenfield & Gross, 2000). The inextricable links between various factors related to the educational environment, pedagogy, resources, family structure, parenting etc. make it difficult to establish a direct link between the use of technology and learning outcomes. Previous studies have mostly chosen to focus on only one or other aspect. The research presented here aims to take account of as many of these aspects as possible, by drawing upon data from a large-scale study, in particular, by looking into the relationship that home computing practices might have with other parenting practices in home, referred to as HLE. HLE proved to be the strongest predictor of children's cognitive development in pre- and primary school education after age (Sylva et al., 2004). The literature reports a significant linear relationship between HCU and HLE (e.g. Valentine et al., 2009). Therefore, conceptually there might be an interactional relationship between HCU, HLE and children's school achievement. This relationship might confuse or mediate the impact of HCU on children's achievement, so it was necessary to design a more methodologically rigorous study that would test both direct and indirect effects.

Methodology

Proposed analytical framework for associating HCU with school achievement

A twofold analytical model is proposed. In the first layer, the direct main effects of HCU are investigated with reference to children's performance in national assessments. McFarlane et al. (2000) called this model the Direct Impact Model and this designation is retained in the present study (see Figure 1). This framework assumes that ICT learning gains are directly linked to children's scores in school assessments.

The second layer of the analytical framework, assumes that the relationship between the effects of children's HCU and their performance in school is affected by the influence of other factors. McFarlane et al. (2000) called this the Social -Contextual Impact Model but did not test the model in an empirical study. The present study tested both models of interaction (mediation and moderation), and the mediation effects were shown to be significant, and are reported here. The mediation framework assumes that the impact of HCU on children's attainment goes through another variable such as HLE and self-regulation. The choice of these variables was informed by the theoretical and empirical testing of all variables.

Applied methods and instruments

In order to address the topics under consideration, a quantitative, longitudinal, value-added, large scale, research strategy was adopted. Some of the methodological limitations of ICT research (as discussed by Gardner & Galanouli, 2004) have been addressed in this study by using a large sample longitudinal study which includes a range of covariates. It draws upon the data from the study called Effective Provision of Preschool, Primary and Secondary Education (EPPSE), the aim of which was to investigate the effects of pre-school education and care on children's development for children aged 3-7 years old. However, it was extended to study the same cohort to the end of compulsory education at age 16 (1997-2013). The research team collected a wide range of data on the developmental profiles of nearly 3,000 children, background circumstances related to the children themselves, their parents and their HLE, and the pre-schools, primary and secondary schools they attended. Various methods of data collection were used including one-to-one parental interviews, postal questionnaires for parents, questionnaires for pupils on their attitudes to school, teachers' assessment of pupils' social and behavioural development, one-to-one standardized assessments of children on their cognitive development and national assessment scores for the end of each Key Stage. The sample was nationally representative, from Six Local Authorities in England (see Sylva et al., 2004).

Data on the use of home computers by children on their own and with their parents were obtained through a questionnaire posted to families. The data were collected at two points of time: first when children were in KS1 (Y1 and Y2) and then when they were coming to the end of KS2 (Y5 and Y6). For the rest of data we used the national assessment tests as research instruments. Frequency questions were answered on a 5-point Likert scale: 'never', 'hardly ever', 'occasionally', '1 or 2 times a week', 'everyday'.

Findings

HCU and children's school achievement in Year2

Analyses showed a quadratic trend in the scores where the highest mean score belong to moderate users of home computers, decreasing on both sides (Figure 2). This indicates an optimal level of HCU for both educational (HCUfE) and recreational (HCUfR) purposes. It is interesting to see that non-users of home computers scored lowest (below the sample mean) for both Mathematics and Reading. Non-users of home computers might in fact be those who do not own a home computer and therefore, it reflects a proxy for the children's socio-economic status, although the dataset provides a thorough measure of SES based on their parental occupation and annual income. Further analyses confirmed the match between these two measurements. Also post-hoc tests of Analysis of Variance (ANOVA) showed that there was a significant difference be-

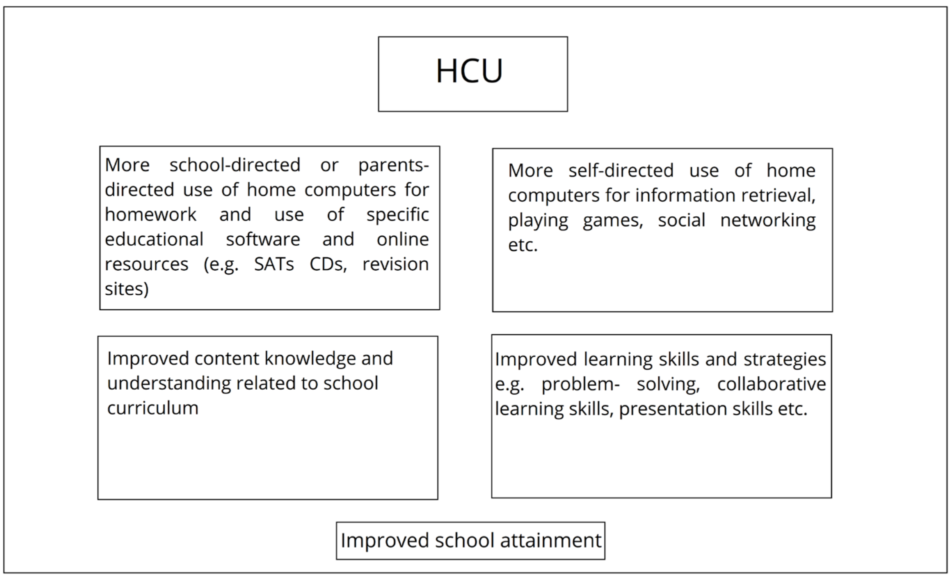

Figure 1. Driect Impact Model

tween the mean scores of non-users and all other groups except everyday users, $F(4)= 14.36$, $p< .01$ (for HCUfE and Reading) and $F(8)= 4.30$, $p< .01$ (for HCUfR and Reading). Similar patterns were repeated for Mathematics.

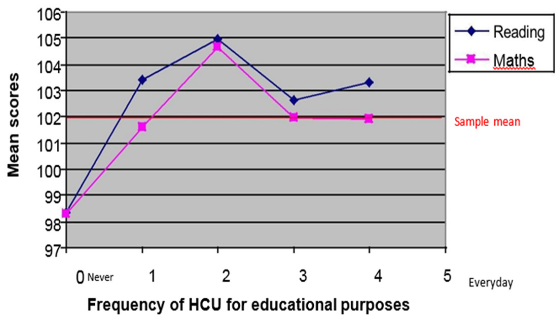

Figure 2. HCU for educational purposes and Y2 national assessments

Recreational use of home computers also showed a similar quadratic relationship with Reading and Mathematics scores. Both non-users and everyday users of home computers for recreational purposes scored lower than moderate users (Figure 3). In contrast to educational use, high users of home computers for recreational use scored much lower than their counterparts in the educational use group. This might reinforce the findings of past studies that suggested that extensive game playing on computers is associated with weaker performance in school (e.g. Valentine et. al., 2005).

The next step of the analyses was to include covariates that were theoretically and empirically shown to confound effects on children's school achievement. Therefore, hierarchical linear regressions were applied. Five stepwise incremental models are produced and reported here to demonstrate the stage at which the effects of HCU fade away. Model 1 has only one explanatory variable (i.e. HCU) and model 5 has the most. Each model includes the explanatory variables of the previous model plus its own ones. The results show that children's HCU for education was positively associated with their reading scores in Y2 after taking into account their prior attainment; but after inputting family circumstances, HCU for education was no longer a significant predictor for their reading scores. Recreational use of home computers showed a negative but not significant relationship with children's reading scores after the baseline measurement was taken into account (Table 1).

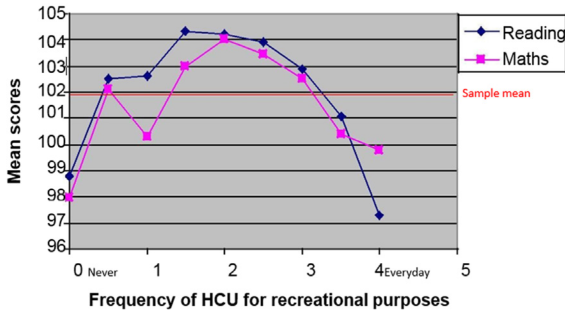

Figure 3. HCU for recreational purposes and Y2 national assessments

For Mathematics, the data showed that levels of educational use of home computers in KS1 was a weak but significant predictor of children's Mathematics scores in Y2 after controlling for their prior performance, and individual circumstances like gender and early-years developmental problems. However, as with Reading, after taking into account the effects of family and HLE circumstances, this weak relationship faded away (Table 2).

HCU and children's school achievement in Year6

The scatter plots show an inverted U-shape relationship similar to that reported for KS1. The weakest performance in all three subjects belongs to non- and low users of home computers (Figure 4). Post-hoc tests of ANOVA also confirmed that there was a significant difference between the mean score of the non/low users (0-3 on 12 point HCUfE scale) and that of moderate users (4-10) for Mathematics and Reading but not for Writing: $F(12)= 4.01$, $p< .01$ for Mathematics and $F(12)=2.42$, $p< .01$ for Reading.

Table 1. *Hierarchical linear regression results for Reading Y2*

Models/ variables	Model 1 (HCU only)	Model 2 (Baseline Mesaure)	Model 3 (Individual block)	Model 4	Model 5 (HLE block)
HLE					. 06**
Mother's education				.07**	.06*
SES				-.11**	-.11**
FSM				ns	ns
No. of siblings				ns	ns
Gender			.06**	.08**	.06**
Ethnicity (Compared to White UK heritage)			-.05* (Black African; other ethnic groups)	ns	ns
EAL			.06**	.06**	.06**
Developmental problems			.05*	.05*	.05*
Pre-reading at entry to school		.59**	.57**	.50**	.49**
HCU for Education	.17**	.05**	.04**	ns	ns
HCU for Recreation	-.11**	ns	ns	ns	ns
Variance explained	.020	.357	.370	.395	.398
Constant	.05	.04	.04	.03	.03

*Significant at p= or < .05; **Significant at p= or <.01; # just failed to reach significance level at p= .05; ns: non-significant

Table 2. *Hierarchical linear regression results for Reading Y2*

Models/ variables	Model 1 (HCU only)	Model 2 (Baseline Mesaure)	Model 3 (Individual block)	Model 4	Model 5 (HLE block)
HLE					.07**
Mother's education				.08**	.08*
SES				-.09**	-.11**
FSM				ns	ns
No. of siblings				ns	ns
Gender			-.11**	-.10**	-.11**
Ethnicity (Compared to White UK heritage)			ns	ns	ns
EAL			ns	ns	ns
Developmental problems			.05*	.05*	.05*
Pre-reading at entry to school		.50**	.51**	.45**	.44**
HCU for Education	.13**	.06**	.07**	ns	ns
HCU for Recreation	-.05**	ns	ns	ns	ns
Variance explained	.011	.262	.279	.301	.304
Constant	.04	.04	.04	.03	.03

**Significant at p= or <.05; **Significant at p= or <.01; # just failed to reach significance level at p= .05; ns: non-significant*

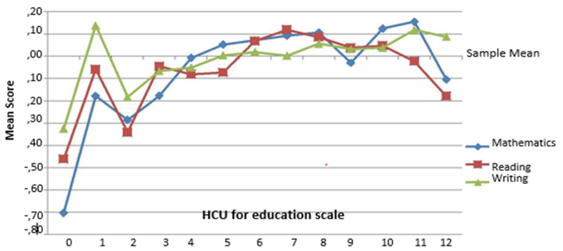

Figure 4. HCU for education and Y6 school attainment (bivariate analysis)

The scatter plots also confirm the linear positive relationship between recreational use of home computers and children's Mathematics scores, and a negative (though not statistically significant) relationship with Reading and Writing. The analyses from the hierarchical linear regression models show that after controlling for children's prior achievement and their demographic background (Model 5), the relationship became non-significant for both educational and recreational use of home computers, as well as for children's reading and writing scores in Year6 (Table 3).

Analyses of the effects of using home computers in KS2 on children's Mathematics scores in Year6 showed that af-

Table 3. *Significant predictors of Reading Y6*

Models/ variables	Model 1 (HCU only)	Model 2 (Baseline Mesaure)	Model 3 (Individual block)	Model 4	Model 5 (HLE block)
K2 HLE					
Child's independent learning activities					.08**
Parents' informal learning activities					.05**
Mother's education				.07**	.06**
SES				-.09**	-.09**
FSM				-. 06**	-.06**
Gender			.05*	.06**	.04*
Ethnicity (Compared to White UK heritage)			-.05# (Pakistani)	ns	ns
Reading Year 2		.70**	.69**	.63**	.60**
HCU for Education	.06#	.06**	.07**	ns	ns
HCU for Recreation	- .04ns	. 02ns	ns	ns	ns
Variance explained	.002	.49	.495	.51	.53
Constant	.05	.03	.03	.03	.03

**Significant at p= or < .05; **Significant at p= or <.01; # just failed to reach significance level at p= .05; ns: non-significant* ter children's prior achievements were taken into account, primary significant effects faded away.

Interaction models

To deal with possible moderating or mediating effects of HLE and self- regulation on the relationship between children's HCU and school performance, the interaction product term was first applied to test the moderating effects, but the regression coefficients failed to reach a significance level. Therefore, it was decided not to go further along this line, but to investigate the mediating effects of HLE and self - regulation. Using path analysis, models were made for all three school achievement measurements, but only Mathematics and Reading showed a significant mediating effect of HLE/self-regulation.

Mediating effects of HLE. Figure 5 shows the path model for the mediating effect of one aspect of HLE in Key Stage2, which relates a child's independent learning activities (reading on their own, doing homework, painting, drawing and making models on their own) to the relationship between HCU for educational purposes and a child's performance in Y6 Reading. The path model reports the theoretical relationships between components of the model, and it is based mainly on past studies and theoretical frameworks. The presented model tests the hypothesis that educational use of home computers might have some positive effects on children's non-computer learning activities at home (e.g. reading) which in turn might positively influence children's performance in Reading assessment. This model, as stated in section 3.1, is referred to as the Social-Contextual Impact Model (McFarlane et.al, 2000) and is tested in the present study. The model shows that the indirect (or mediating) effect is statistically significant (path coefficient = .08, $p< .05$). The direct effect, however, was shown to be statistically non-significant. The path coefficients are reported while the influences of other variables are partialled out.

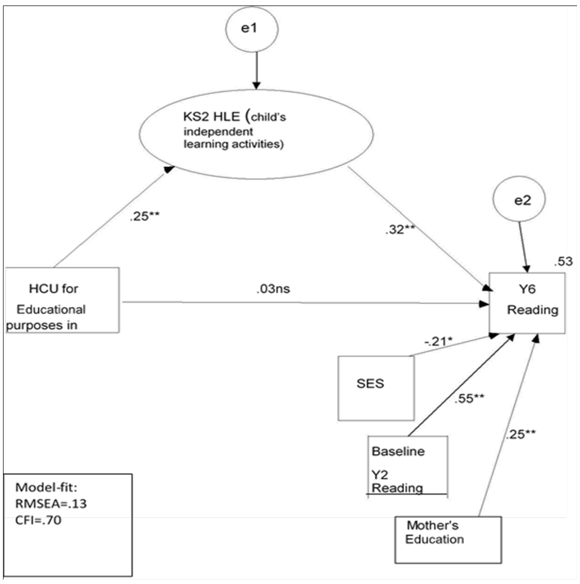

Figure 5. Path model for mediating effect of HLE on the relationship between HCUfE and Mathematics Y6 (* significant at p< .05 ** significant at p< .01)

Mediating effects of self-regulation. The hypothesis here is that educational use of home computers has some positive effects on children's self-regulated learning strategies which in turn positively affect children's performance in Mathematics. Children's self-regulation was assessed from entry to the study at age 3 up to age 12 through a questionnaire filled out by pupils' teachers who had been with them for at least one school term. For the primary school period, a Strength and Difficulties Questionnaire was applied (Goodman, 1997). A principal component analysis and Confirmatory Factor Analysis (CFA) were carried out to identify the underlying dimensions of social behaviour. Four factors, including self-regulation, were identified. This included items such as pupils liking to work things out for themselves; pupils rarely seeking help, choosing activities on their own, and being able to move on to a new activity after finishing a task. Figure 6 shows that the direct effect of HCU for educational purposes on children's mathematics in Y6 was not significant (path coefficient= .04) after controlling for their prior attainment level in Y2 and the effects of their demographic circumstances. However, the indirect effect through improving a child's self-regulation is shown to be statistically significant (path coefficient= .11, $p< .01$). This effect is the value- added net effect because it is over and beyond the effects of background circumstances and takes account of children's baseline measurements (i.e. Mathematics Y2).

Discussion

Table 4 summarizes and compares the main effects of the two types of HCU (i.e. educational and recreational) and other demographic background circumstances on children's school achievement measurements at two points in Year2 and Year6. It reports the extent of the effect from the final model (i.e. Model 5) of the hierarchical linear regression data analysis in which baseline measurements and a child's individual, family and HLE circumstances are included in the equation. Therefore, Figure 6 shows the net value-added effects. For HCU, the table shows that the amount and type of HCU do not have an extra 'impact' on children's school achievement for Reading and Mathematics in primary school. However, a child's individual, family and HLE circumstances continue to predict academic outcomes (both attainment and progress) in Year6. The extent of the effect in Table 4 reports the magnitude of effects for each predictor on the progress a child has made from a baseline measurement. For Year2, the progress is also measured from the time children entered primary school and for Year6; the baseline is Year 2. For Reading and Mathematics, gender, ethnicity and pre-school developmental problems, family socio-economic status (SES), the mother's educational level, eligibility for Free School Meals (FSM) and HLE showed significant effects that are distinct from the effects of all other circumstances considered.

A comparison of the extent of the effect from various background circumstances across the two key stages shows that a child's individual, family and HLE circumstances remain significant predictors of attainment/progress in Year6, although their influence is weaker than when children were in Year2. Taken together, one can conclude that children who belong to the highest SES category (i.e. professional non-manual group) have significantly higher attainment and progress in school, net of the influence of family income and educational level, although there is a positive correlation between family SES, income level and educational level. HLE also showed a consistent significant effect on both Reading and Mathematics in primary school after the effects of a child's individual and family circumstances are partialled out. Early years HLE significantly predicted Y2 Reading and Mathematics, and KS2 HLE significantly predicted Year6 Reading and Mathematics. The effect sizes of early years HLE and KS2 HLE are not comparable because different measurements were applied. However, they both include parenting and child practices in the home. One big difference between early years HLE and KS2 HLE is that as children are 11/12 in KS2, they do more independent activities at home than those involving their parents. Moreover, the nature of their activities becomes more diverse. Therefore, instead of having one measurement for HLE in KS2, the statistical analyses revealed three underlying aspects of HLE. The strongest aspect of HLE for predicting Reading and Mathematics was 'children's independent learning activities' such as reading on their own. In addition, 'parents' informal learning activities' such as taking the child to libraries and museums in KS2 showed a significant relationship with raised scores in Reading at age 11.

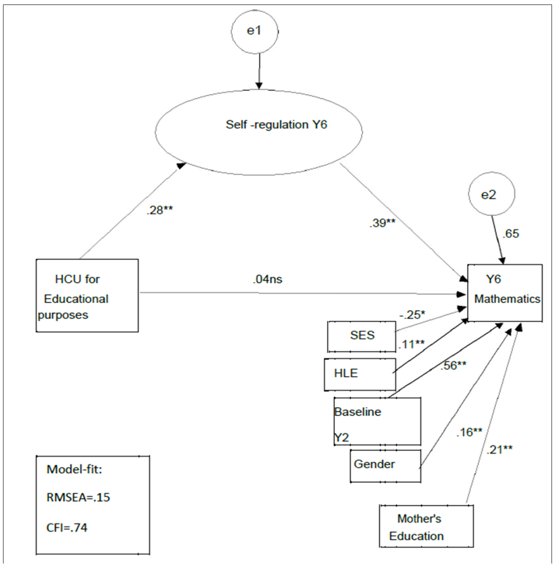

Figure 6. Path model for mediating effect of self-regulation on the relationship between HCUfE and Reading Y6 (* significant at p< .05 ** significant at p< .01)

To sum up, the overarching aim of this study was to investigate whether learning gains through HCU are associated with children's performance in schools. The current study showed that using home computers for both educational and recreational purposes does not have an 'extra' direct impact on children's performance and progress in Reading, Mathematics and Writing in primary school over and beyond what could be expected based on their prior achievement, and individual, family and HLE circumstances. However, it was children's family circumstances, particularly socio-economic status and the mother's educational level and HLE, which "overcame" the initial positive influence of HCU for education on children's school outcomes. This finding is compatible with the results from most other studies on primary pupils such as Valentine et al. (2005), O'Dwyer et al. (2005 & 2008), and Jackson et al. (2006). This can be partially explained by referring to Nechyba, McEwan and Older-Aguilar's (1999) argument about the inextricable link between various factors that influence a child's school achievement. One can argue that children's HCU is a small factor within an array of more important ones.

One further explanation for this could be related to the 'time-on-task' factor. The relatively low level of daily HCU for both educational and recreational purposes by primary pupils in the present study might create a 'floor effect'. This might have reduced the explanatory power of the models. The current study reported that in KS1 fewer than 3% were daily users of home computers for educational purposes and a further 20% reported weekly use. Similarly, in KS2 only 14% of pupils were reported to be daily users. Although, as pupils grew up to age 10/11, their frequency of HCU for educational purposes increased, it was still infrequent compared to the reported proportions of daily users among KS3 and KS4 pupils from other studies

Table 4. *Summary of significant HCU and background characteristics main effects on Year2 and Yea 6 outcomes*

Variables	Labels	Reading Year 2	Reading Year 6	Mathematics Year 2	Mathematics Year 6
HCU for education		ns	ns	ns	ns
HCU for recreation		ns	ns	ns	ns
Baseline		.49	.60	.44	.60
Measure					
Child factors	Compared to				
Gender (Girls)	boys	.06	.04	-.11	-.09
Ethnicity (Pakistani)	White UK				-.04
Early years developmental problems (none)	Having 1+ developmental problem	.06		.05	
Early years behavioural problems (none)	Having 1+ behavioural problem				
Family factors		-.11	-.09	-.08	-.08
SES (high to low)		.06	.06	.07	.13
Mother's education (low to high)		-.04	-.06		
Eligibility for Free School Meal (proxy for economic status)	Non-FSM				
HLE		.06		.07	
Early years HLE			.08		.07
KS2 HLE (child independent learning activities)			.05		
KS2 HLE (parents' informal learning activities)					

ns: non-significant

(e.g. 34% of KS4 pupils were reported as daily users in Valentine et al., 2005). Most investigations on the effects of computer use have found more consistent and extensive effects among older pupils in KS3 and KS4 (e.g. Harrison et al., 2005). Furthermore, even studies on computer use in the classroom show that spending a small amount of time on a computer-based task was not significantly associated with children's performance in the related assessments (e.g. O'Dwyer et al., 2005).

Moreover, studies have shown that during primary school, the part that family and parenting practices play in children's school success is much stronger than that for secondary school pupils and it is even more influential than any in-school initiative. For instance Mann, Shakeshaft, Becker, and Kottkamp (1999) found that almost 70% of the variation in pupils' scores was associated with factors related to family SES, parenting, and home life and only 30% was associated with school-based educational initiatives.
Despite the statistically non-significant results of the main effect models, the mediating effect models revealed an interesting relationship between educational use of home computers, HLE, self-regulation and two of the outcome measurements. In the first model, educational use of home computers in KS2 was significantly associated with one aspect of KS2 HLE (e.g. child's independent learning activities at home) which itself was significantly associated with Y6 Reading scores. Considering the relatively large sample used in the present study, the mediating effects of HCU on Reading scores through HLE is a significant finding. However, the available data in the EPPSE dataset do not allow pressing this relationship further, and there will be a need for additional investigation as to why and how HCU further stimulates children's independent academic activities at home (e.g. reading and drawing) which in turn positively influence their Reading scores. There are no data available on specific educational activities of children on home computers, but one might speculate that some computer-based educational activities (such as preparing a school newsletter) require and stimulate children to read, understand and summarise both paper and electronic resources. These reading and beyond-reading activities which are often carried out cooperatively might then positively influence children's performance in Reading assessment.

Similarly, the second mediating model showed a significant indirect relationship between HCU for educational purposes and Year6 Mathematics scores through children's self-regulation scores. Again, the data cannot be used to claim a causal relationship, but one might explain this mediating relationship through self-regulation theories (e.g. Zimmerman, 2002) and the empirical evidence for a significant relationship between children's self-regulation and their school achievement (e.g. Sylva et al., 2008). One might speculate that the capabilities of new technologies might afford self-regulated learning opportunities for users, which in turn might positively influence their performance in mathematics assessment. Some of these opportunities are: the provision of an exploratory environment for children's development of experiential discovery learning; the creation of a learning environment in which help-seeking is an attractive option when problems are encountered; and learning to collaborate with other players in group game playing. Furthermore, the original EPPSE study (Sylva et al., 2008) and other similar investigations have shown that children's self-regulation is a strong predictor of their performance in school achievement assessments. This chain of relationships is shown to be statistically significant in the present study, but why and how this might occur in practice requires further investigation.

Conclusion

The findings of the present study maintain that through the use of home computers, children gain some learning skills and strategies such as self-regulated Learning, problem-solving abilities, independent and autonomous learning activities, and collaborative learning skills. This theoretical understanding of the benefits of ICT for learning is based on the views of constructivists (e.g. Pappert, 1980) and socio- constructivists (e.g. Säljö, 1998) concerning learning with computers (see Noroozi et al., 2016, 2017, 2018). This indirect relationship through self- regulation was not significant for Reading and Writing in neither Year 6 nor any of the Y2 school achievement outcomes. Therefore, it seems that subject area and age are two important factors in the indirect impact-model.

One contribution of the present research is that it expanded the indirect-impact model, originally proposed by McFarlane et al. (2000). This is because the model was primarily presented for school-based ICT use. Use of the model for HCU and applying it within an array of a child's individual, family and HLE circumstances showed that HCU might not only influence the enhancement of meta-cognitive skills such as self-regulation, but it might also stimulate some aspects of the HLE for Y6 children. The HLE then influences children's performance in schools. The current study provides empirical evidence for only some aspects of HLE and Reading scores in Year6. Further studies are required to confirm the findings and test other aspects of HLE and other subject areas.

A policy implication of this study is relevant to the government's 'Home Access' program (BECTA, 2008). The study showed that nearly all (90%) children use computers at home and that frequency of use increased with age. Therefore, a main part of children's home time is filled with HCU. However, the magnitude of the direct effects of HCU for educational purposes on children's school performance is low and non-significant after controlling for other factors. This might be a warning for the government against huge investment on ICT for education. Children instead spend most of their HCU time playing games. However, certain uses of HCU have positive impacts on children's school performance, which come through enhancing and stimulating other capabilities (e.g. self-regulation) and educational activities (e.g. HLE). Therefore, ICT policies should aim at strategies and programs that make this indirect link stronger. For instance, a stronger home-school link is required in which teachers lead children and families to use particular software and online resources which are in line with those capabilities and educational activities. A final implication of this study for practice is that parental programs need to seriously address HLE and children's activities if they want to take advantage of the benefits of home computers. There can be initiatives in which familial and individual activities are planned around home computers.

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Semantic and Syntactic Fraction Understanding

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Abstract

This study begins by connecting semantic elaboration with conceptual understanding and syntactic elaboration with procedural understanding in the context of fractions. Through case studies and discourse analysis, the work and communication of students in fourth through sixth grade is analyzed to determine the extent of their semantic and syntactic elaboration regarding fractions and fraction operations. Findings are that, while some students emphasized one form of elaboration over the other, some students demonstrated use of both forms of elaboration. Indeed, it is wondered if semantic and syntactic elaboration should be seen as more complementary than adversarial.

Keywords: Semantic Elaboration, Syntactic Elaboration, Conceptual Understanding, Procedural Understanding

Introduction

While researchers continue to examine students' learning of fractions (Kara & Incikabı, 2018; Hyde, Khanum, & Spelke, 2014; Inglis & Gilmore, 2013; Jacob & Nieder, 2009; Meert, Grégoire, & Noël, 2009; Murray, Olivier, & Human, 1996), students continue to possess limited understanding of fractions and often remain unable to adequately communicate ideas associated with fractions. Meert, Grégoire, and Noël (2009) and Murray, Olivier, and Human (1996) report specific challenges students encounter, including a lack of conceptual understanding of equality. These challenges lead to students incorrectly performing arithmetic operations on fraction and developing their own incorrect arithmetic heuristics.

Although semantics and syntax have received considerable attention in student mathematical communication, some opine that the limited consideration of student fraction understanding through these lenses is probably due to teachers themselves possessing insufficient understanding of semantics and syntax in the context of fractions (Meert, Grégoire, & Noël, 2009; Opfer & DeVries, 2008; Sasanguie et al., 2013). However, some researchers recognize that contextualizing fraction learning in real-world problems helps to demonstrate the semantic structure of fractions and leads to greater learning (Leibovich & Ansari 2016; Newstead & Murray, 1998; Opfer & DeVries, 2008). It can be inferred that a number of factors can contribute to students gaining deeper semantic understanding of fractions. Understanding semantics and syntax may be the cornerstone to unpacking the difficulties learners encounter when learning, and performing operations on, fractions.

This study suggests that students could be aided in their learning of the principles of fractions by understanding semantics, syntax, and their relationships. The current research begins an initial dialog defining student use of semantic and syntactic elaborations in the context of fraction arithmetic and understanding.

Literature Review

Investigating the role of semantics and syntax in respect to language learning is far from novel and considering the roles of semantics and syntax in the context of mathematical communication is becoming increasingly in vogue (e.g., Meert, Grégoire, & Noël, 2009; Opfer & DeVries, 2008; Sasanguie et al., 2013). In the context of mathematics, particularly with fractions, many have ascribed semantics with connecting mathematics to real-world scenarios (e.g., Leibovich & Ansari 2016; Opfer & DeVries, 2008). In this current investigation, we will extend upon this notion and define particular fractional arithmetic and understanding as either semantic or syntactic.

Throughout the 60s, 70s, and even 90s, significant work investigated students' language of fractions (Halliday, 1975, 1993; Halliday, McIntosh, & Strevens, 1964). While these studies extended the literature regarding students' use of language in mathematics, they led to inconsistencies in defining and identifying students' syntactic and semantic interaction with mathematics in general and fractions in particular. Subsequently, various themes have emerged in unpacking students semantic and syntactic interaction with mathematics. These include: semantic and syntactic elaborations; understanding and communication of fractions and semantics, syntax, and sequencing.

Semantic (Global and Conceptual) and Syntactic (Local and Procedural) Interactions

Kaput (1987a, 1978b) identifies two types of interactions a person can have with a mathematical representation: syntactic elaboration (interacting with a representation by directly manipulating the symbols in the representations without reference to the meaning of the idea represented) and semantic elaboration (interacting with a representation based on the features of the ideas represented, rather than the symbols themselves). In the context of representational in-

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terpretation, syntactic elaboration is akin to interpreting an expression by considering local characteristics of the expression and semantic elaboration as connecting the representation more globally to overarching ideas (Duval, 2006, Kaput, 1987a, 1987b). For example, in respect to a fraction such as 2/3, a student may syntactically focus on the local attributes of the 2, the 3, or the division symbol or operation without semantically connecting 2/3 to the global notion of rational numbers.

In a parallel manner, while local, syntactic interactions can be equated to instrumental or procedural understanding (using processes and algorithms to produce results) of mathematics, global semantic interactions hold similarities with conceptual understanding (the ability to see interconnections among ideas) (Hallett, Nunes, & Bryant, 2010). While some have recognized elementary students' difficulties with fractions concepts (e.g., Braithwaite, Pyke, & Siegler, 2017; Bulgar, 2003; Gabriel et al., 2013; Siegler et al., 2011; Tirosh, 2000; Van Steenbrugge, Lesage, Valcke, & Desoete, 2014), some equate this to students primarily possessing procedural knowledge of fractions and operations (e.g., Byrnes & Wasik, 1991; Kerslake, 1986; Rittle-Johnson, Siegler, & Alibali, 2001). Interestingly, while Kerslake (1986) has determined that some students can have success with some fraction operations using primarily procedural knowledge, Byrnes and Wasik (1991) contend that conceptual knowledge regarding fractions is the prerequisite and Hallett, Nunes, and Bryant (2010) suggest that some students rely more on procedural understanding and others on conceptual understanding. However, when students demonstrate lesser conceptual understanding and greater procedural understanding, this may limit their understanding of fractions (Van Steenbrugge et al., 2014) and lead to the development of misunderstandings (Hallett Nunes, & Bryant, 2010; Kerslake, 1986).

Communication and Procedural and Conceptual Misunderstanding Fractions

Based on whole number bias and other misconceptions, students' understanding and communication of fractions continues to be investigated (e.g., Bartelet, Ansari, Vaessen, & Blomert, 2014; DeWolf, Rapp, Bassok, & Holyoak, 2014; Iuculano & Butterworth, 2011; Kallai & Tzelgov, 2009; Lyons, Price, Vaessen, Blomert, & Ansari1, 2014; Meert, Grégoire, & Noël, 2009; Opfer & DeVries, 2008; Schneider & Siegler, 2010). Research reveals that some student difficulties with fractions are born from misunderstandings with natural numbers (e.g., Siegler, Thompson, & Schneider, 2011; Stafylidou & Vosniadou, 2004; Van Steenbrugge et al., 2014). This is because, children's knowledge of natural numbers can inhibit later fraction learning (Siegler et al., 2011). The primary reason may be due in part to the fact that fractions are inconsistent with the counting principles, counting-based algorithms, and numerical ordering applicable to natural numbers (Stafylidou & Vosniadou, 2004). This results in whole number bias leading to misconceptions (Van Steenbrugge et al., 2014). Additionally, the multi-dimensional nature of the fraction construct also leads to student difficulties (e.g., Charalambous & Pitta-Pantazi, 2007; Kieren, 1976; Van Steenbrugge et al., 2014). To overcome this, fractions must be considered through interconnected subconstructs (i.e., ratio, operator, quotient, and measure) (Kieren, 1976) and the part-whole construct (Behr, Lesh, Post, & Silver, 1983), all defined by Charalambous and Pitta-Pantazi (2007) and Van Steenbrugge et al. (2014).

Connecting to previous discussions of procedural (local and syntactic) and conceptual (global and semantic) understanding, fraction misunderstandings are generally classified as either procedural or conceptual. Whole number bias, incorrect fraction operation strategies, and division of two fractions are usually classified as procedural fraction misunderstanding and fraction equivalence and abuses of the previously mentioned subconstructs are classified as conceptual misunderstandings (Braithwaite et al., 2017; Bulgar, 2003; Charalambous & Pitta-Pantazi, 2007; Gabriel et al., 2013; Siegler et al., 2011; Tirosh, 2000; Van Steenbrugge et al., 2014).

Misconceptions emanating from students' incorrect intuitions and informal experiences has also been one factor why learning of fractions decimals is challenging. For instance, Newstead and Murray (1998) argue that students' difficulties with division by a fraction may be due to limitations arising from their own intuitions and real-life experiences. They also argue that, when division by fractions decontextualized, the result may conflict with students' previously held notions as it can produce a quotient greater than either the dividend or the divisor. Altogether, teachers should expose learners to a variety of situations and contexts regarding division.

Altogether, the literature seems to indicate that whole-number schemes can be somewhat unsuitable for fraction conceptualization and that children's limited understanding of fractions may be born from their limited ability to communicate (interpret and produce) linguistically posed mathematical ideas. For instance, when there is a seeming lack of understanding of equality of fractions, there seems to commensurately be a limited ability to communicate ideas associated with equivalent fractions (Kolkman, Kroesbergen, & Leseman, 2013; Leibovich & Ansari 2016; Meert, Grégoire, & Noël, 2009; Opfer & DeVries, 2008; Sasanguie, et al., 2013).

Semantics, Syntax, and Poor Sequencing

Since the early 1990s, numerous studies suggest that there seem to be different reasons why children find it difficult to learn fractions. The work of Baroody and Hume (1991), Streefland (1991) and D'Ambrosio and Mewborn (1994) have chronicled the problems as poor sequencing and limited variety of fractions. Thus, limited content in the form of teaching only halves and quarters and the use of pre–partitioned manipulatives, could be contributory factors. Some studies also demonstrate that semantic alignment largely correlates with the learning of fractions (DeWolf et al., 2014; Kallai & Tzelgov, 2009; Park & Brannon, 2013, 2014; Sasanguie et al, 2013; Schulze, 2016; Schleppegrell, 2007; Thwaite, 2015; Turkan, de Oliveira, Lee, & Phelps, 2014; van Lier & Walqui, 2012). Both children and adults find it easier and more natural to solve or construct semantically-aligned rather than misaligned word problems (DeWolf et al., 2014). Some studies have explored grades four and six students' concept and operation understanding through success and misconceptions (DeWolf et al., 2014; Kallai & Tzelgov, 2009; Park & Brannon, 2013; Schulze, 2016; Schleppegrell, 2007; van Lier & Walqui, 2012). Summarily, research suggests that entities in a problem situation evoke semantic relations.

Objective of the study

Thus far, there is sufficient reason to suggest that recognizing students' semantic versus syntactic understanding of fractions may be key in unraveling the difficulties in learning fractions. Contextualized in this recognition, the current study investigates student work and communication regarding fractions and arithmetic operations on fractions and seeks to interpret their understanding from the lens of semantic and syntactic understanding of fractions.

Methodology

In order to gain insight into student understanding of fractions in the form of semantic versus syntactic understandings, the research methodology employed in this study are case studies and discourse analysis (Bogden & Biklen, 2003; Creswell, 2003; Goldin, 2000; Miles & Huberman, 1994; Wodak & Meyer, 2009). This study sought to explore, fourth-, fifth-, sixth-, and seventh-grade student understating of fractions and decimals through the lens of semantic (global and conceptual) and syntactic (local and procedural) elaboration (Braithwaite, Pyke, & Siegler, 2017; Bulgar, 2003; Byrnes & Wasik, 1991; Gabriel et al., 2013; Kaput, 1987a, 1987b; Kerslake, 1986; Hallett, Nunes, & Bryant, 2010; Rittle-Johnson, Siegler, & Alibali, 2001; Siegler et al., 2011; Tirosh, 2000; Van Steenbrugge, et al., 2014). Seven distinct scenarios of student-student or student-teacher interactions regarding various contexts of fraction and decimal understanding were investigated. These included:

Scenario 1: Sixth grade student and teacher (ten years teaching with 4 years in this grade with a master's degree in education) discussing fraction simplification.

Scenario 2: Fourth grade student and teacher (five years teaching in the same grade) comparing fraction magnitude.

Scenario 3: Fifth grade student and teacher (seven years teaching all in the same grade with a master's degree in education) discussing equivalent fractions equal to 1.

Scenario 4: Sixth grade student and teacher (in her first year if teaching) discussing a technique for fraction addition.

Scenario 5: Sixth grade student and teacher (thirteen years teaching with seven years in this grade) discussing the lowest form of a fraction.

Scenario 6: Four seventh-grade students discussing simplifying fractions.

The case study aspect focused on participants who were students in various classrooms in the southeastern part of the United States. The discourse analysis focused on each transcript which was a subset of a larger set of transcripts recording the interactions of students and teachers in the context of fractions and decimals. Each recorded interaction took place in the students' and their respective teachers' regular classroom setting in the southeastern United States. These schools and teachers were selected singularly for their convenience to the researcher and participating teachers. Videotaping occurred on days when the teachers were anticipating covering the respective fraction and decimal topics.

To unpack meaning from the transcripts (Creswell, 2003), the data was systematically analyzed (Bogden & Biklen, 2003). Videotapes capturing student work and communication were transcribed. Discourse analysis (Wodak, 2009; Wodak & Meyer, 2009) was employed to investigate student understanding; this was completed both by individual researchers and then again by the team of researchers. The themes of semantic and syntactic elaborations were characterized and behaviors connoting such elaborations were coded in the transcripts. Check-coding (Miles & Huberman, 1994) was employed (the coding of each individual researcher was considered by the team of researchers, differences were reconciled, and refinements were made) to allow researchers to reach consensus on the analysis of all transcripts.

Results and Initial Analyses

In this section, we provide portions of transcripts together within initial analysis of semantic versus syntactic elaboration through seven scenarios of student-teacher and student-student interactions.

Scenario 1: Sixth grade student and teacher (ten years teaching with 4 years in this grade with a master's degree in education) discussing fraction simplification.

Student: *A ratio is just a fraction of fractions.*

Teacher: *What do you mean?*

Student: *Well, a fraction is a part to a whole. And a ratio is a part to a part.*

Teacher: *Yes? Can you give me an example?*

Student: *Well let's say that we have 5 boys and 7 girls in a class. The ratio of boys to girls is 5 to 7. But that is a part to a part.*

Teacher: *Right? But, then, how does that make it a fraction of fractions?*

Student: *Well, of the class is boys and of the class is girls. These are both part to whole fractions. So, if I set them up as a fraction of fractions, I get:*

$$\frac{\frac{5}{12}}{\frac{7}{12}} = \frac{5}{12} \div \frac{7}{12} = \frac{5}{12} \times \frac{12}{7} = \frac{5}{\cancel{12}} \times \frac{\cancel{12}}{7} = \frac{5}{7}$$

Teacher: So, you get the fraction $\frac{5}{7}$*?*

Student: Well, kinda. I get the ratio $\frac{5}{7}$ *or 5 to 7.*

Teacher: But is that a ratio or a fraction?

Student: It is a ratio.

Teacher: I see what you mean that a ratio is a fraction of fractions. But you are starting with fraction and performing operations on fractions. How does it become a ratio?

Student: I'm not really sure. But it does work.

Teacher: Where did you see this idea?

Student: I came up with it myself.

This student's articulations seem to demonstrate none of the previously mentioned fraction misunderstandings classified as either semantic (conceptual) or syntactic (procedural) (Braithwaite et al., 2017; Bulgar, 2003; Charalambous & Pitta-Pantazi, 2007; Gabriel et al., 2013; Siegler et al., 2011; Tirosh, 2000; Van Steenbrugge et al., 2014). While the respondent's interpretation of a ratio as a fraction of fractions is somewhat irregular, respondent demonstrates a sufficiently sophisticated understanding of fractions and ratios that respondent interconnects the ideas without having previously received instruction regarding such. Indeed, Kieren (1976) and others have noted that recognizing fractions through the subconstruct of ratio is a component of conceptually understanding fractions. Thus, this student seems to primarily demonstrate semantic elaboration regarding fractions and decimals.

Scenario 2: Fourth grade student and teacher (five years teaching in the same grade) comparing fraction magnitude.

Teacher: Which is greater, $\frac{2}{5}$, $\frac{3}{5}$, *or* $\frac{2}{4}$*? And why?*

Student: Well, $\frac{3}{5}$ *has the biggest top number?*

Teacher: So, is $\frac{3}{5}$ *the greatest number? Is that all that matters?*

Student: No. $\frac{2}{4}$ *has the smallest bottom number.*

Teacher: So is $\frac{2}{4}$ the greatest number?

Student: I think that I want the number with the biggest top and the smallest bottom. But that is two different numbers. I know that is bigger than. And I know that $\frac{3}{5}$ is bigger than $\frac{2}{5}$. But, I'm stuck between $\frac{2}{4}$ and $\frac{3}{5}$.

Teacher: Do you have any ideas on how to figure that out?

Student: I could make pictures.

Teacher: Ok.

Student: (Show circles shaded of $\frac{2}{4}$ and $\frac{3}{5}$.) I think that is a little bit bigger. But not much. So, must be the biggest.

This student attempts to compare the magnitude (or measurement) of fractions, which could be a semantic task, by syntactically isolating the numerators and then the denominators and not semantically considering the entirety of the fractional representation. The respondent does not seem to consider the fraction as a ratio, operator, quotient, and measure (Kieren, 1976), or as a part-whole construct (Behr et al., 1983), all associated with semantic, conceptual understanding (Charalambous & Pitta-Pantazi, 2007; Van Steenbrugge et al., 2014). However, respondent work does seem to exemplify whole number bias, accepted as syntactic, procedural understanding.

Scenario 3: Fifth grade student and teacher (seven years teaching all in the same grade with a master's degree in education) discussing equivalent fractions equal to 1.

Teacher: Is $\frac{31}{31}$ greater than $\frac{9}{9}$?

Student: Yes.

Teacher: Why?

Student: 31 is bigger than 9.

Teacher: But it is not 31 and 9. It is $\frac{31}{31}$ and $\frac{9}{9}$.

Student: I know.

Teacher: So, what are the parts and the wholes?

Student: For $\frac{31}{31}$, the whole is 31 and the parts are 31. For $\frac{9}{9}$, the whole is 9 and the parts are 9.

Teacher: So, for $\frac{31}{31}$ you have all the parts of the whole and for $\frac{9}{9}$ you have all the parts of the whole. So, in both cases, you are using all of the whole.

Student: But there is more of the whole for $\frac{31}{31}$.

Teacher: But aren't each of the 31 parts of the whole smaller than each of the 9 parts of the whole?

Student: Yes. 31 parts would be very small.

Teacher: But you would be using all of them.

Student: The 9 pieces would each be bigger.

Teacher: And, again, you would be using all of them.

Student: But 31 parts is still a lot more than 9 parts. So, $\frac{31}{31}$ has to be bigger.

This student seems to syntactically employ whole number bias and measurement, as she focuses on the numerator of each fraction rather than on the semantic constructs of ratio, operator, and quotient (Behr et al., 1983; Charalambous & Pitta-Pantazi, 2007; Kieren, 1976; van Steenbrugge et al, 2014). However, respondent communication demonstrates some incomplete notions of the part-whole construct and fraction equivalence, two ideas commonly recognized as semantic in nature. Altogether, then, respondent seems to ineffectively employ both syntactic elaborations and, to the extent that it is attempted, two dimensions of semantic elaborations.

Scenario 4: Sixth grade student and teacher (in her first year if teaching) discussing a technique for fraction addition.

Student: Callie and me got the same answer, but we did it different ways.

Teacher: For what problem?

Student: We did $\frac{1}{2} - \frac{9}{6}$. We both got -1 for an answer.

Teacher: Let's see how you did it.

Student: Callie did:

$$\frac{1}{2} + \frac{-9}{6} = \frac{3}{3} \cdot \frac{1}{2} + \frac{-9}{6} = \frac{3}{6} + \frac{-9}{6} = \frac{-6}{6} = -1$$

I did: $\frac{1}{2} + \frac{-9}{6} = \frac{1+(-9)}{2+6} = \frac{-8}{8} = -1$. *We both got -1.*

Teacher: Callie's technique is correct. Your technique is wrong.

Student: But we got the same answer.

Teacher: I think that you just got luck with your example. Most of the time, it won't work correctly.

Student: But if it works here, maybe it works on all kinds of problems. And it's easier to just add the tops and bottoms.

Teacher: But that does not always work. In fact, it rarely works.

Student: But maybe we should try it first and see if it works.

Teacher: But, if you try your way first and then have to try Callie's way to see if the answers are the same, this doubles your work. Just do it Callie's way.

Student: But my way is easier.

Teacher: Just do it Callie's way.

In the context of this brief student-teacher interaction, we reluctantly avoid commenting on the teacher's articulations and singularly focus on the student's communication. This student demonstrates whole number bias in the technique she employs toward incorrect fraction arithmetic strategies; these are both recognized as a syntactic (procedural) misunderstandings (Braithwaite, Pyke, & Siegler, 2017; Bulgar, 2003; Charalambous & Pitta-Pantazi, 2007; Gabriel et al., 2013; Siegler, Thompson, & Schneider, 2011; Tirosh, 2000; Van Steenbrugge et al., 2014). Indeed, little semantic elaboration can be recognized in her work apart from some semblance of recognizing the notion of expected equality or equivalence.

Scenario 5: Sixth grade student and teacher (thirteen years teaching with seven years in this grade) discussing the lowest form of a fraction.

Teacher: How can you tell if a fraction is simplified?

Student: When the numerator and denominator are as small as possible.

Teacher: The numbers 3 and 6 are pretty small. Is $\frac{3}{6}$ simplified?

Student: No, it can be smaller.

Teacher: What can be smaller?

Student: $\frac{3}{6}$ can be made smaller to $\frac{1}{2}$.

Teacher: Is $\frac{1}{2}$ less than $\frac{3}{6}$?

Student: No. It's not less than. They are equal. Just the top and bottom are smaller.

Teacher: Ok. Can we make $\frac{1}{2}$ into an equivalent fraction with a numerator and denominator less than 1 and 2?

Student: I don't think so.

Teacher: Which is less, 1 or -1?

Student: -1.

Teacher: Which is less, 2 or -2?

Student: -2.

Teacher: So, $\frac{-1}{-2}$ must be more simplified than $\frac{1}{2}$?

Student: No. We don't do that.

Teacher: I know that we don't usually do that. But I am wondering if my argument is sound.

Student: Since, -1 is smaller than 1 and -2 is smaller than 2, I guess that $\frac{-1}{-2}$ can be more simplified than $\frac{1}{2}$. But we don't do that.

Teacher: Then $\frac{-3}{-6}$ must be more simplified and $\frac{-30}{-60}$ must be more simplified and $\frac{-300}{-600}$ must be more simplified.

Student: That is silly. The numbers are getting bigger.

Teacher: Are they getting "bigger"?

Student: No, they are getting smaller, but looking bigger. Something is wrong.

Teacher: Well, let's go in another direction. Which is smaller, 1 or 0.1?

Student: 0.1.

Teacher: Which is smaller, 2 or 0.2?

Student: 0.2.

Teacher: Then $\frac{0.1}{0.2}$ must be more simplified than $\frac{1}{2}$.

Student: We don't do that either. We don't put decimals in fractions.

Teacher: I agree that this is quite unusual. But is $\frac{0.1}{0.2}$ more simplified than $\frac{1}{2}$?

Student: Since 1÷10 = 0.1 and 2÷10 = 0.2, I think that $\frac{1}{2}=\frac{0.1}{0.2}$.

Teacher: The question is not if they are equal. The question is whether the fraction with the smaller numerator and denominator is more simplified.

Student: If we use "smaller", then it is more simplified. But that isn't right.

Teacher: What isn't right?

Student: I think that the word "smaller" is causing the problem.

This student demonstrates unwavering semantic understanding of fraction equivalence, even when challenged with unusual questions. His communication reveals no commonly anticipated evidence of syntactic elaboration apart, possibly, from using problematic verbiage such as "smaller" and "bigger" numbers in respect to simplifying fractions and whole number bias in preferring natural numbers in the numerator and denominator over other rational number options. The limitation of the transcripts, however, do not provide sufficient evidence for other semantic elaborations apart, possibly, from recognizing magnitude or measurement among integers and decimal values.

Scenario 6: Seventh-grade students discussing simplifying fractions.

Teacher: Simplify the expression $\frac{86}{40}$.

Class: Most students produce $\frac{43}{20}$ or $2\frac{3}{20}$.

Student 1: I think that it should be $\frac{215}{100}$.

Student 2: Why did you get that? All your numbers are bigger.

Student 3: I got 2.15. I divided on my calculator. That's simpler to do.

Student 4: But don't you need to keep it a fraction?

Student 1: I kept it as a fraction.

Student 2: But your numbers are all bigger. That's not simplifying.

Student 3: [To Student 1] Why did you get bigger numbers? What did you do?

Student 1: I wanted the bottom to be 100. So, after I saw that $\frac{86}{40}$ is the same as $\frac{43}{20}$, I realized that 20 times 5 is 100. So, I multiplied the top by 5 also. So, $\frac{86}{40}$ became $\frac{43}{20}$, which became 43 times 5 over 20 times 5, or $\frac{215}{100}$.

Student 3: But why make the bottom into 100, which is a bigger number?

Student 1: Because we have been making all our fractions into decimals and percents, I thought that if I made the bottom number 100, then when I could do this easier. Since $\frac{86}{40}$ is the same as $\frac{215}{100}$, that is the same as 215%. And then, since percent means part of 100 and dividing by 100 means that I can just move the decimal place, I knew that $\frac{215}{100}$ is the same as 2.15.

Student 3: Hey, that's what I got.

Student 1: So, $\frac{215}{100}$ was the easiest way for me to go from a fraction to percents to decimals.

Student 4: [To the teacher] Should we all make our fractions have 100 in the bottom?

Student 2: I want to keep doing it my way. It makes more sense to me if I simplify and get smaller numbers first. Then I can do what [Student 1] is doing.

This brief interaction among numerous students demonstrates a greater number of dimensions of semantic and syntactic elaborations. For instance, syntactic elaboration may be recognized in: Students 2 and 3 mentioning "bigger" numbers, focusing on the numerator and denominator of the fraction and possibly employing whole number bias; Student 4 questioning if the simplification of a fraction remains a fraction; Student 3 immediately employing a calculator to convert the fraction to division; Student 3 focusing solely on the denominator of 100; Student 4 questioning if all fractions should be converted to denominators of 100; and Student 2 insisting on retaining a previously understood heuristic even if a novel one may be more valuable. However, some of these elaborations and others may also be recognized as semantic elaborations such as: Student 3 immediately using a calculator may be the result of recognizing the fraction as an operation or a quotient; Student 1 employing the notion of equivalence to recognize that $\frac{86}{40} = \frac{43}{20} = \frac{215}{100}$; and Student 1 connecting $\frac{215}{100}$ to 215% and 2.15.

Discussion and Implications

As previously mentioned, this study expanded upon the common notion of semantic and syntactic elaboration of fractions. Herein, semantic elaborations of fractions include the subconstructs of ratio, operator, quotient, measure, and part-whole together with fraction equivalence and syntactic elaborations include whole number bias, incorrect fraction operation strategies, and errors associated with division of two fractions (Behr et al., 1983; Braithwaite et al., 2017; Bulgar, 2003; Charalambous & Pitta-Pantazi, 2007; Gabriel et al., 2013; Kieren, 1976; Siegler, Thompson, & Schneider, 2011; Tirosh, 2000; van Steenbrugge et al., 2014). With these dimensions in place, it was possible to analyze fourth through sixth grade student work and communication through the lens of semantic versus syntactic elaboration.

Consistent with Hallett, Nunes, and Bryant (2010), it was revealed that individual students tend to employ semantic elaboration to a greater or lesser extent than syntactic elaboration. However, it may be overly simplistic to state that students do better when they more frequently employ semantic elaborations. While some have noted that limited conceptual (semantic) knowledge of fractions hinders fraction learning (Byrnes & Wasik, 1991; Kerslake, 1986; Rittle-Johnson, Siegler, & Alibali, 2001) and that conceptual knowledge regarding fractions is a prerequisite for correctly performing fraction arithmetic, Kerslake (1986) argues that students can solve some fraction problems primarily using procedural knowledge with only limited conceptual understanding and Rittle-Johnson Siegler, and Alibali (2001) note that conceptual and procedural (syntactic) knowledge grow and develop simultaneously, supporting each other as they develop. Indeed, Hallett Nunes, and Bryant (2010) note that students often combine conceptual and procedural knowledge. This was observed in student participant work in this study, as some students exhibited aspects of both semantic and syntactic understanding.

While a goal of education may be to develop student semantic fraction understanding, we may not yet fully know the extent to which semantic and syntactic understanding complement, rather than compete with, each other. In this study we considered student's preferences toward one elaboration over another. Left uninvestigated is the interplay of these elaborations. This is left for future research.

However, best revealed through Scenario 6, interpreting a student's use of semantic or syntactic elaboration may be more complex than previously revealed. Indeed, articulations must be carefully interpreted from the context of the scenario at play as well as through the sequence of articulations among the interloculars. This reveals that far more research is needed in this realm in the future. The most significant implication of this study may be that, in the context of fraction learning, some students seemingly employ aspects of both semantic and syntactic elaborations. Thus, as previously stated, it may be that these forms of elaborations should be considered as complementary rather than as oppositional. Teachers may learn to value both types of elaborations rather than have as a singular goal that all students perform primarily semantic elaborations (conceptual understanding).

Notably, this study focused on student learning and not on teaching. Unfortunately, this study cannot make a claim regarding teaching techniques that might either increase student semantic elaboration or help students blend semantic and syntactic elaborations in the context of fraction learning or learning in any other mathematical domain. Indeed, this study makes no claims that any particular pedagogy might accomplish this. Thus, an implication from this study may be the need to investigate these pedagogies. However, the authors hope that this is done with caution. Attempting to construct a curriculum that enhances semantic elaborations for all may diminish the recognition that all students may balance semantic and syntactic elaborations differently. Altogether, much more research is needed in this area. We welcome others to join us in this investigation.

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A Comparison of the Middle School Science Programmes in Turkey, Singapore and Kazakhstan

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Abstract

Comparative education is important for recognising the education systems of different countries for bringing new practices into the education system and for ensuring educational equality among different societies. This study discusses the education systems of Turkey, Singapore and Kazakhstan. The science programmes of the three countries are compared in terms of their general objectives, processes and skills, content, measurement and evaluation approaches and learning outcomes. This is a comparative education research with a horizontal approach. The middle school science curriculum of the three countries was used as a data collection tool. As a method of analysis, document analysis was carried out. According to the results of the research, the programmes of all three countries are similar in terms of their general aims, processes and skills, but in contrast they have differences in measurement and evaluation approaches and learning approaches

Keywords: Comparative Study, Science Curriculum, Turkey, Singapore, Kazakhstan

Introduction

A country's education system cannot be described as being in a coincidental relationship with its own society. All education systems adopt the characteristics of the society in which they exist and reflect that society's values (Baskan, 2006). Education allows societies to transfer their cultural heritage to future generations and to adapt to developments happening at the time. Individuals living in the community are always looking for ways to determine what they have achieved from their past experiences and how they will meet the needs of their age. One of the purposes of education is to guide individuals in these ways. This can only be achieved by increasing the quality of teaching programmes. In this context, a teaching program consists of four steps: content, goal, learning-teaching process, evaluation (Demirel, 2013; Incikabi, 2011). The four elements of the new programmes that are delivered in terms of developing technology and certain other conditions must be reorganised and constantly updated (Özdemir, 2009). In this process of updating, the various programmes are compared with each other to establish any missing parts, and the models are designed with the strengths of the programmes in mind in order to shape the programmes under development. Already, this process tends to start from the ideal when developing the programme. The development, improvement and adaptation of each of the lessons is a matter of relevance for the educators and the rulers of the state (AAAS, 1990). It is important to increase the quality of the teaching programme in order to increase the efficiency of teaching (Ayas, Çepni & Özbay, 1994; Uysal & İncikabı, 2017, 2018).

The relationship between the components of the programmes is dynamic. Every change can affect other elements (Demirel, 2013). Every curriculum needs careful design before being put into practice. For this reason, the curriculum should be tested. The curriculum fosters students' conceptual learning, together with their fluency in operations and communications by testing their knowledge, all the while stressing the development of their problem-solving skills (Ciltas, 2013). Although some judgements are made about the draft curriculum based on previous information, it is possible to make a more precise judgement after the draft is put into practice and the effects on learning are determined. The most powerful factor that makes evaluation necessary in terms of programme improvement is the fact that any programme is initially based on a hypothetical structure (Yılmaz, 2006). On the basis of programme development activities, the programme must be designed, tested, tweaked or corrected and finally implemented (Demirel, 2013).

The aim of science education is to enable individuals to use science process skills; in other words, to be able to define the problems around them, to observe, to analyse, to hypothesise, to experiment, to conclude, to generalise and to apply the information they have using the necessary skills. Students can gain these science process skills through certain science education activities (Khayotha & Sitti, 2015). The science curriculum, in its dynamic structure, is continuously renewed. Changes in the programmes are inevitable due to the conditions and technology that are developed together with the basic concepts and skills that have been inherited from past programmes (Demirci, 1994). It would be more useful to study and investigate the education systems of different countries and to shape education practices according to the results of these surveys. This would avoid the need to conduct research that would not go far beyond the facts that have already been identified in scientific studies in other countries (Demirel, 2013). 'Comparative Education' is the name of the field in which such studies are conducted.

As part of this research, the aim is to compare middle school science programmes in secondary schools in Turkey, Singapore and Kazakhstan. According to the 2015 TIMSS results,

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the top four rankings in science are in Singapore, Japan, China-Taiwan and the Republic of Korea. In this research, the science curriculum in Turkey is compared with the Singapore curriculum, which came second in the 2011 TIMSS and first in 2015, and with Kazakshtan which is one of the most developing countries according to the 2011 and 2015 reports from TIMSS. The similarities and differences between the programmes of these countries have been determined and this study attempts to define the extent to which the practices within the programmes can respond to the needs of the respective countries by taking their specific conditions into consideration.

In recent years, the ineffectiveness of science education has become one of the most important problems in the Turkish Education System (Eş & Sarıkaya, 2010) such as lack of scientific process, misdistribution of learning areas. For this reason, it is always necessary to review the 'Science Teaching Programmes' and to make the necessary updates based on the changes happening in other countries.

Yılmaz and Çavuş (2016) compared issues in secondary school physics in Kosovo and Turkey according to grade level, objectives and units studied in terms of number of hours and outcomes. According to the study, the purpose of the teaching programmes in Turkey was identified as being clearer. In addition, it was understood that the subjects are linear in Kosovo but in a spiral structure in Turkey. However, it was determined that the outcomes related to physics are higher and there are more hours of lesson time than in Kosovo.

Güneş and Aksan (2015) compared Turkey and South Korea's biology curriculum. In making this comparison, the basic approaches, aims, areas of learning and structure of the programmes were taken into account. According to the results of the research, there are differences in the naming of the subjects in each country's programmes. On the other hand, it was determined that there are similarities in the general objectives and basic approaches of the programme. Yavuz-Topaloğlu and Balkan-Kıyıcı (2015) compared Turkey's and Australia's Science Programmes in their studies in terms of their content and purpose. According to the survey results, it was found that in the Turkish programmes, the environment, technology and other content are given more emphasis. It was also seen that the learning outcomes of the Australian programmes are lower. Özata-Yücel and Özkan (2014) compared Turkey, the UK, Ireland, Finland, Canada, New Zealand and the United States (New Jersey and Massachusetts) and found that the ecosystem, biodiversity and environmental problems are located in the curriculum. According to the results of the research, it can be seen that the related issues are handled differently in different countries. We have reached the conclusion that Turkey's education programmes give more importance to technology. Eş and Sarıkaya (2010) addressed the Irish curriculum in their study and compared the curriculum of the two countries in terms of content and purpose. According to the survey results, there is no content related to information and communication technologies in the Turkish curriculum. At the same time, compared to Ireland's curriculum, it was also found that in Turkey, there are more outcomes related to concepts.

Similarly, Eş, Sarikaya, Ekici and Ekici (2010) compared Canada's Ontario curriculum with Turkey's science education programme for general purposes, and they compared these programmes in terms of the underlying approaches and teaching-learning processes. According to the results of the research, it was found that both programmes have similar learning areas, addressing a student-centred approach. However, in terms of the overall objectives, Turkey's programme was identified as having more clear explanations. Tasar and Karaçam (2008) compared the Science and Technology/Engineering programmes of Turkey and Massachusetts. This comparison was made by taking the aims, contents and principles of the programmes into account. According to the results, the MBTM curriculum is followed in order to teach individuals the consciousness of American society. In Turkey, however, society and nation are not mentioned in the curriculum. Science literacy has always been considered important and plays a significant role in driving Singapore's technological and economic developments. In the Singapore education system, Science is introduced formally at grade 3 and it remains a core subject area throughout a child's ten years of compulsory education from elementary to high school levels (Koh & Lee, 2007).

Aslan (2005) studied the Singapore curriculum and compared the programmes of the two countries in terms of student achievements, teaching-learning experiences and test situations. According to the results of the research, it was stated that the main purpose in Turkey is to provide topic coverage in the Science Teaching Programme. In the Singapore Science Teaching Programme, it is understood that the main purpose is to explore themes and the subjects are the vehicles to achieve this. Turkey's general exams only consist of multiple-choice questions but in Singapore, the exams consist of multiple-choice and open-ended questions. Turkey's evaluation activities aim to determine the degree of achievement of the outcomes contained in the unit. Studies in classroom assessments in Singapore are clearly presented to teachers.

The significance of this research is that it enables us to compare the programmes of the countries which are the subject of the research, to determine the good and the incomplete aspects of the programmes, to make a synthesis in terms of the programmes and to make possible suggestions and shed light on the work to be done thereafter. Due to the newness of the programme, there have not been enough comparative studies in the field of science education, especially in the countries that have realised innovations in recent years (Eş & Sarıkaya, 2010). For the purpose of the research, the problem to be investigated is 'what are the similarities and differences between middle school science teaching programmes in Turkey, Singapore and Kazakhstan?'

As a result of this problem, the following sub-problems will be investigated:

1. What are the similarities and differences in terms of overall objectives in the middle school science teaching programmes in Turkey, Singapore and Kazakhstan?

2. What are the similarities and differences of the middle school science teaching programmes of Turkey, Singapore and Kazakhstan in terms of the skills and processes they include?

3. What are the similarities and differences in the middle school science teaching programmes in Turkey, Singapore and Kazakhstan in terms of learning areas?

4. What are the similarities and differences in the middle school science teaching programmes in Turkey, Singapore and Kazakhstan in terms of measurement and evaluation?

5. What are the similarities and differences in the middle school science teaching programmes (at the eighth grade level) in Turkey, Singapore and Kazakhstan in terms of outcomes?

Method

Research Model

In the study, an analytic method which is called the 'Bereday Model' is used. This approach of Bereday (1964 as cited in Bray, Adamson & Mason, 2014) is examined in two ways—comparative and field study—while two or more countries are examined. This model is in four stages: defining, interpreting, combining and comparing.

• Identification: At this stage, sources for the comparative elements are identified and discussed.

• Interpretation: When interpreting, the elements to be compared are evaluated from different directions (philosophical, geographical, social etc.).

• Combination: The elements of the different countries are paired together for comparison. Thus, the differences and similarities between them are determined.

• Comparison: The comparison is concluded in an objective and consistent manner by setting out the data obtained from pairing at the comparison stage.

The educational systems of the three countries that are examined during the identification phase are presented for informational purposes without any comments. The information defined in the interpretation phase is expressed. At the time of assembly, matched data were presented together and tables were arranged. The comparative stage of the research is expressed in the results section.

Data Collection Tools

As a data source in this research, the secondary school science programmes of Turkey, Singapore and Kazakhstan were used. Since the Singapore curriculum was written in English, it was directly examined by the researcher. However, the curriculum of Kazakhstan was translated into Turkish from an official language of the country through an interpreter. All three countries have access to the curriculum from official Internet sites.

Data Analysis

In the analysis of the data obtained in this study, the document analysis method was preferred. The document analysis method is an approach that includes systematically reviewing each element in order to objectively reveal the patterns obtained from the scope (Böke, 2002). At the beginning of the study, in order to create the coding list, the related literature was examined. Two experts working independently were involved in the coding process of the data. Both experts have numerous studies regarding program analysis and development. As a result of the first coding, the agreement rate (reliability coefficient) between coders was calculated as 83.5% according to the Miles and Huberman (1994) formula. The coders came together and discussed the items causing the dispute and reached an agreement on each item.

Findings

In this section, the science courses of Turkey, Singapore and Kazakhstan are provided by a comparison of the programmes according to the research problems.

Table 1. *Comparison of general objectives*

Objective	Turkey	Singapore	Kazakhstan
Gain Basic Knowledge	To give basic information about Biology, Physics, Chemistry, Earth, Sky and Environmental Sciences, Health and Natural Disasters	To help students develop the field knowledge needed to conduct science research	Continuity in the development of knowledge, skills and abilities acquired in primary school
Gain Environmental Consciousness	In the process of discovering nature and understanding the relationship between man and the environment, adopting scientific process skills and a scientific research approach and finding solutions to the problems encountered	This goal aims to develop students' curiosity, interest and tendencies in science and technology related issues and their interest and attention to the environment	Education and research activities, rational nature management and environmental protection skills, necessary skills to ensure the safety of human and social life
Science-Society-Technology Interaction	To raise awareness of how science affects society and technology	To develop students' curiosity, interest and tendencies in science and technology related issues	Creating the interaction of nature, society and the economy
Career Consciousness	To develop science-related career consciousness	Aims to increase awareness that scientific research and applied areas involve cooperation and accumulation activities	
Solving Daily Problems	To take responsibility for everyday life problems and to use knowledge of science, scientific process skills and other life skills to solve these problems	Attracting students to science-related issues that concern their lives, society and the environment	To develop mental and creative skills to solve life problems
The Formation of Scientific Knowledge	Helping understand how scientists create scientific knowledge, the processes it goes through and how this new knowledge is used in new research		
The formation of Scientific Knowledge as a Result of Common culture	To contribute to the understanding that science is the result of the common endeavour of scientists from all cultures and to develop a sense of appreciation of scientific studies		Development of an integrated information, value and attitude system corresponding to a multinational assembly
Security Consciousness	To recognise the importance of safety in scientific studies and to contribute to its implementation		

The comparison of the programmes in terms of general objectives

The findings of the coding obtained from the expressions containing the general objectives of all three programmes are given in Table 1.

According to Table 1, all three programmes have similar common objectives. It was understood that although 2 objectives are uniquely listed in Turkey's curriculum, for the 4 objectives out of listed 8 ones, all of three countries have common statements.

As regards the aims in the programmes, it is observed that the four objectives of the curriculum are to provide basic information, to gain environmental awareness, to provide science-society-technology interaction and to solve daily life problems. Taking into account the outstanding objectives of these common themes, it is seen that all three countries are aiming to provide the students with basic knowledge.

In particular, it was stated that Kazakhstan's science curriculum is primarily aimed at the development of knowledge gained in previous years. The science curriculum in Singapore also outlines the necessity of providing basic knowledge to conduct science research. Within the environmental awareness theme, all three programmes aim to create interest in environmental problems that students are experiencing and aim to develop a scientific approach in order to solve these problems.

Besides, some themes only appear in the list for one country. For example, 'patriotism consciousness' is emphasised only in the Kazakhstan science education programme. In Turkey, the basis of the Law as regards the National Education curriculum is stated. In this respect, the students are educated as citizens who depend on Atatürk Nationalism, Atatürk's Reforms and Principles and the Constitutional expression and as citizens who are embracing, protecting and developing the national, moral, spiritual and cultural values of the Turkish people. They are expected to love and attempt to glorify human rights and the constitution; they are expected to be democratic and know their duties and responsibilities towards the Republic of Turkey.

In fact, this goal also demonstrates the need for students to have patriotism consciousness. Similarly, 'security awareness in scientific research' was openly expressed only in the Turkish science curriculum. As regards the aims in the programmes, it can be seen that all three programmes have general objectives. While the objectives in the Turkish Science Education Programme and the Singapore Science Education Programme include the entire programme, the specific objectives of each course are included in the Kazakhstan Science Education Programme. Numerically, there are 12 goals in the Turkish Science Education Programme and three objectives in the Singapore Science Education Programme, whereas in the Kazakhstan Science Education Programme, there is one general objective and 35 objectives in the total of all the courses.

When the content is compared, it can be seen that all three programmes aim to encourage students in the habit of doing scientific research, to make them learn basic information about the subjects and to increase their knowledge of science subjects.

As a matter of fact, it has been determined that each lesson in the Kazakhstan Science Education Programme aims to give its students specific qualifications.

The comparison of the programmes in terms of process and skills

The findings of the coding obtained from the expressions containing the processes and skills of all three programmes are given in Table 2.

In all three programmes, it can be seen that the skills to be taught to the students are included and the processes that are required to acquire these skills are included. While these skills and processes are handled in detail in the Singapore Science Education Programme, details are not given in the Turkish Science Education Programme and the Kazakhstan Science Education Programme. When the themes created are examined, it can be seen that the themes of 'creative thinking', 'scientific process skills' and 'scientific literacy' take place in all three countries.

It has been determined that in the Singapore Science Education Programme and the Turkish Science Education Programme, the skills of 'joint research and questioning' and 'problem solving and effective communication' are provided to the students. In addition, competencies that have been abbreviated as scientific process skills in the Turkish Science Education Programme have been found to take place in detail in the Singapore Science Education Programme as follows: hypothesis formation, problem

Table 2. *Comparison of processes and skills*

Process-Skill	Turkey	Singapore	Kazakhstan
Research-Question	X	X	
Solving Problems	X	X	
Cooperation	X		
Self Confidence	X		
Effective Decision Making	X		
Effective Communication	X	X	
Sustainable Development Consciousness	X		
Life time Learning	X		
Technology-Society-Environment	X		
Attitude	X		X
Perception	X		
Value	X		
Creative Thinking	X	X	X
Scientific Process Skills	X	X	X
Scientific Literacy	X	X	X

identification, prediction, observation, comparison and analysis.

Comparing programmes in terms of learning areas

The findings of the coding obtained from the expressions containing the learning fields of all three programmes are given in Table 3.

Table 3. *Comparison of content domains*

Learning Areas		
Turkey	Singapore	Kazakhstan
Knowledge	Variety	
Skill	Models	
Hearing	Systems	
Science-Technology-Society-Environment	Interactions	

When all three programmes are compared in terms of learning areas, it can be seen that learning areas are not included in the Kazakhstan Science Education Programme at first. There are four learning areas in the Turkish Science Education Programme and the Singapore Science Education Programme but these learning areas are named differently. While dividing the Turkish Science Education Programme learning areas into sub-learning areas, they identified the Singapore Science Education Programme learning areas as themes and associated them with topics. There are sub-learning areas in the Turkish Science Education Programme. Their explanation is also given in the programme.

It can be said that when comparing the Singapore Programme with the Turkish Programme, the sub-learning areas in the Turkish Programme are explained under the heading of skills and process in the Singapore Programme. The Turkish Science Education Programme can be considered as the most detailed programme in terms of learning areas.

Comparison of programmes in terms of measurement and evaluation approach.

The findings of the coding obtained from the expressions containing the measurement and evaluation approach of all three programmes are given in Table 4.

When all three programmes are compared in terms of measurement and evaluation approaches, it can be seen that the measurement and evaluation approach within the Kazakhstan Science Education Programme takes the form of 'main results', 'personal results' and 'system activity results'. Of these, 'fundamental' and 'system activity results' are explained as a demonstration of the adoption of the complementary evaluation approach.

Personal outcomes are said to be appropriate for the process evaluation approach because it is said that the students are made to learn about their learning levels through that approach. As a result of the comparison of the Turkish and the Singapore programmes in terms of the measurement and evaluation approach, it can be seen that both programmes have a similar approach. Both programmes seem to suggest a complementary and formative assessment and evaluation approach. In particular, the collection effect of performance-based evaluations within the Singapore Science Education Programme is also given as a percentage.

In addition, performance-based evaluation tools recommended in the programme of Singapore are listed.

Table 4. *Comparison of measurement and evaluation approach*

Approach	Turkey	Singapore	Kazakhstan
Process Assessment	A measurement-evaluation approach has been adopted in order to ensure that pupils are monitored and guided in the process, learning difficulties are identified and remedied and continuous feedback is provided to support meaningful and lasting learning	Collected studies provide a continuous record of the students' development and progress in information acquisition, understanding of scientific concepts, application of process skills and development of attitudes	The level of education of students is assessed from three perspectives: main results, personal results, system effectiveness results
Complement	For this reason, it is recommended to assess the performance of the student at the end of the process with the learning product presented by the student	Assessment measures the extent to which the desired knowledge, skills and attitudes are attained by students. While completing the teaching and learning process, it gives formative and summary information to teachers, students, schools and families	
Feedback	Self and peer assessment approaches have been adopted, with the use of complementary measurement tools and techniques, with an emphasis on a process-oriented assessment approach, where the student has the opportunity to assess himself and his peers	The assessment provides feedback to the students and helps them understand their strengths and weaknesses	
Use of Technology	Technology is also used to monitor and evaluate students' learning process and performance at the end of this process		

However, it has been stated that such an evaluation is recommended to be used in the programme of Turkey. However, the reasons and necessity of the evaluation approach within the Singapore Science Education Programme are explained in detail.

Comparison of the programmes in terms of outcomes

The findings of the coding obtained from the expressions containing the outcomes of all three programmes are given in Table 5.

Table 5. *Comparison of number of learning outcomes*

Number of Learning Outcomes		
Turkey	Singapore	Kazakhstan
252	89	113

A sample outcome from Turkey:

> ** Associates the occurrence of seasons with the inclination of the earth's rotation axis and the orbit around the Sun.*

A sample outcome from Singapore:

> ** Substances may be classified as elements, compounds and mixtures.*

A sample outcome from Kazakhstan:

> ** Cognitive methods of chemical experimental bases and chemical substances.*

When comparing the achievements of all three programmes, it can be seen that the achievements are not expressed as sentences in KSEP. Instead, concepts are included in the subject headings. As a result of comparing the TSEP and the SSEP in terms of achievements, it can be seen that the two programmes have a similar approach. The behaviours that both programmes should try to develop in students are expressed in short and clear sentences.

However, there are more numerical gains in the Turkish Science Education Programme. It can be considered that this is due to the fact that the Turkish Science Education Programme contains more detailed sub-learning areas. At the same time, there is no such division in the Singapore Programme as the achievements within the Turkish Science Education Programme are disaggregated on a class basis

Results and Discussion

The results that were obtained according to the research findings show similarities in terms of the general objectives of the Science Curriculum of Turkey, Singapore and Kazakhstan. The current framework of the Singapore Science Curriculum is centred on Science as an Inquiry. It focuses on the acquisition of general inquiry processes and science process skills which scientists use to make sense of the natural environment (Koh & Lee, 2007). The Turkish curriculum is the most detailed in terms of general objectives. This situation has also been observed in the studies of Yılmazlar and Çavuş (2016) and Eş, Sarıkaya, Ekici and Ekici (2010). In these studies, the teaching programmes implemented in Turkey were found to be more detailed than the ones in Kosovo and in the province of Ontario. However, in addition to the above, the 'Kazakhstan Natural Sciences Curriculum' consists of the descriptions of each course. This detail cannot be seen in Turkey and Singapore.

In terms of the scope of the general objectives, Turkey and Singapore are similar. Both programmes aim to provide students with the habit of conducting scientific research, to provide students with basic information about the subject and to increase students' awareness of science subjects. This situation was seen in the study of Güneş and Aksan (2015) which was about the comparison of the programmes of Turkey and South Korea. In this study, it was found that the objectives of both programmes were to teach students that their goals in life are to acquire and use research skills, inquiry and scientific process skills and to use scientific methods to solve problems that may be encountered in daily life.

Another aim of the study is to compare the programmes of Turkey, Singapore and Kazakhstan in terms of processes and skills. Therefore, all three programmes aim to increase curiosity as regards scientific literacy, analytical thinking and introspection. These results have appeared in the studies of Güneş and Aksan (2015) which compared the biology programmes of South Korea and Turkey. In the present study, it was found that the most advanced curriculum in terms of skills and processes is the 'Singapore Science Teaching Programme'. Another objective of the study is to compare Turkey, Singapore and Kazakhstan in terms of learning areas of the programme. According to the findings of the research in Turkey, learning areas are divided into sub-learning areas but in Singapore learning areas are defined as themes and these are related to the topics. In Kazakhstan, learning areas are not mentioned.

In Turkey's 'Science and Technology Course' the following learning areas take place: 'Live and Life', 'Matter and Change', 'Physical Phenomena' and 'Earth and Universe' with the subject areas 'Skills', 'Hearing', 'Science and Technology- Society-Environment'. There are four themes in the Singapore Science Curriculum named 'Diversity', 'Modeller', 'Systems' and 'Interactions'. This result is similar to the results of Aslan (2005) in the comparative study. According to this study, it is understood that the main purpose is to provide topics in the Science Teaching Programme in Turkey. In the Singapore Science Teaching Programme, it is understood that the main purpose is to provide the theme, and that the subjects are the tools. With the major recent programme revisions such as infusing thinking skills and the Science Practical Assessment, Singaporean science teachers are strongly encouraged to use the inquiry-based instruction and performance-based assessments in their science classrooms. This will ensure that curriculum goals can be met through these authentic learning experiences as students construct meaningful, broadly applicable, well-structured, information-rich knowledge, skills and affective domain attributes (Koh & Lee, 2007).

In Kazakhstan, the main objectives of the education system are: creating necessary conditions for quality education aimed at the formation, development and professional growth of personality based on national and universal human values and achievements of science and practice; development of creative, spiritual and physical skills of a person, formation of the solid ethical principles and a healthy lifestyle, intellectual enrichment by creating conditions for personality development; civic consciousness and patriotic education and cultivating love of the homeland of the Republic of Kazakhstan (Nabi, Zhaxylykova, Kenbaeve, Tolbayev & Bekbaeva, 2016).

Turkey, Singapore and Kazakhstan education programmes were compared in terms of measurement and evaluation approaches. As a result, it was found that measurement and evaluation approaches were not included in the Kazakhstan programme in the first place. Turkey and Singapore programmes were seen as having a more similar approach. Both programmes seem to suggest a complementary and formative assessment and evaluation approach. Particularly in Singapore, the effect of performance-based evaluations as regards the total number is also given as a percentage. These results were also found by Kaytan (2007) in the study that compared the results of Turkey's, Singapore's and Britain's mathematics programmes. In this study, the importance of process evaluation in all three programmes is given.

Suggestions

Depending on the results of the research, the following suggestions are presented:

•While programmes are being prepared, programmes in different countries should be compared.

•In particular, the programmes of countries that have succeeded in international exams comparing achievements of students such as TIMSS and PISA should be examined. However, while doing this, the education systems of the countries should be considered.

•As a research topic, programmes and education systems in different countries at different levels of education can be compared.

•In addition to the aims of this work, the topics and aims of the sciences (such as Physics, Chemistry, Biology) covered in the 'Science Curriculum' may be a new research topic.

•The systems of training the teachers who are practitioners of teaching programmes should also be investigated.

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Investigation of Preservice Preschool Teachers' Views on Environmental Problems and Relevant Suggestions of Solution

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Abstract

This study aimed to investigate preservice preschool teachers' opinions on environmental problems and their suggestions of solution. This study was conducted through case study which is one of the qualitative research design. The study group consisted of 62 senior preservice teachers studying Preschool Teacher Education at a public university in South-eastern Anatolia. Eight semi-structured open-ended questions were asked to preservice teachers as the data collection tool. The data was transferred to the electronic environment and content analysis was made with the NVivo11 program. According to the results, it was observed that the majority of preservice teachers didn't take a course related to the environment during their education, almost half of them didn't participate in any environmental activities, and the most of them did not have membership in any non-governmental organizations related to environment. It was identified that preservice teachers considered global warming as the main global-scale environmental problem, and air, water and soil pollution as other major environmental issues in Turkey. Additionally, the study showed that preservice teachers regarded human factor as the main reason of environmental issues, and that natural environment would be harmed and human life would be challenged as a result of environmental issues. In the solution of environmental issues, the study showed that raising awareness, taking responsibility and receiving education were seen necessary.

Keywords: Environmental Problems, Suggestions, Preservice Preschool Teachers, Qualitative Study

Introduction

Today, many factors such as the rapid population growth, industrialization and reduced natural resources generate various global environmental issues. Those are related to humans' unconscious behaviour against environment and environmental problems. It is, therefore, assumed that the biggest danger of environmental issues is that they are at global scale (Aydın & Kaya, 2011; Harris, 2012; Yücel & Morgil, 1998). Researchers consider the air, water and soil pollution, climate change, global warming, depletion of the ozone layer, decreased biodiversity, depletion of natural resources, reduced green areas, loss or disappearance of various species, desertification and erosion as the biggest environmental issues today (Aydın & Kaya, 2011; Aydoğdu & Gezer, 2006; Harris, 2012; Tsekos & Matthopoulos, 2009). In order to solve environmental issues, researchers emphasize the necessity of helping people to raise awareness through environmental trainings to be conducted at schools to protect the environment (Alım, 2014; Atasoy & Ertürk; 2008; Ünal, Mançuhan & Sayar, 2001; Teksöz, Şahin & Ertepınar, 2010; Yücel & Morgil, 1998). In addition, Erten (2005) also emphasized that activities to be carried out with respect to environmental issues were not the responsibility of the environmentalist NGOs only, but of every individual in the society. The author also stated that the educational institutions would contribute to the development of social consciousness and the development of more environmentally friendly individuals with the responsibilities they would undertake in this regard.

It has been stated that knowledge of environmental issues and their sources will motivate individuals in developing social consciousness for the protection of the environment and more conscious behaviour related to the environment (Erten, 2003). In another study (Erten, 2007), it was emphasized that it is possible to raise environmentally-friendly individuals by including subjects related to the protection of environment in the courses given in schools. It was also stated that gaining awareness about the protection of the environment and positive attitude and value judgments towards the environment could be possible only with the environmental education given in schools (Erten, 2003, 2005; Hungerford, & Volk, 1990; Otto & Pensini, 2017; Palmer, 2002; Varela- Candamio, Novo-Corti, & García-Álvarez, 2018; Yücel & Morgil, 1998). Şimşekli (2004) emphasized that teachers should be a role model about the environmental issues in order to raise awareness with regards to environmental protection, while Yücel and Morgil (1998) stated that the concept of 'environment' must be taught in all levels of education programs starting from primary education and lasting until university, and that individuals should be educated consciously. However, in a study conducted to identify the environmental sensitivity of university students (Yıldırım, Bacanak & Özsoy, 2012), it was concluded that the environmental education course taken by preservice teachers did not turn out to be very effective. In another study (Güven & Aydoğdu, 2012), the extent of awareness of preservice teachers about environmental issues was investigated and preservice teachers were identified to have insufficient level of awareness against environmental issues. From this point of view, it is necessary to emphasize the importance of the content and the way the courses are taught in relation to environmental education.

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Researchers (Kunt & Geçgel, 2013; Otto & Pensini, 2017; Uzun & Sağlam, 2006; Yücel & Morgil, 1998) state that individuals should be conscious of environmental issues, otherwise individuals with negative or disinterested attitudes towards the environment will be insensitive to environmental issues. In addition, it has been stated that both the society and the individuals have common responsibilities in the emergence and prevention of environmental issues (Yılmaz, Morgil, Aktuğ & Göbekli, 2002). From this point of view, it is necessary to raise awareness towards the environment both socially and individually, and to bring about individual and social solutions for environmental issues. It is stated that this can only be achieved by raising people's awareness through an effective environmental education, creating a permanent and sensitive behaviour change to take responsibility in the solution of environmental issues (Erten, 2005; Kesicioğlu & Alisinanoglu, 2009; Kunt ve Geçgel, 2013; Şenyurt, Temel & Özkahraman, 2011; Yılmaz et al., 2002; Yücel & Morgil, 1998). It is stated that this awareness can be achieved by the support of schools and the environmentalist NGOs towards individuals for the protection of the environment (Ozaner, 2004; Tanrıverdi, 2009). Therefore, it is of great importance that both teachers and students should be supported with respect to environmental education to be given in schools (Erten, 2005; Şenyurt, Temel & Özkahraman, 2011; Yılmaz et al., 2002)

Compared with countries in the European Union, it has been identified that "no proper environmental education has been given in Turkey, and informing and raising awareness of people about the environment are the most effective solutions to environmental issues" (Yilmaz et al., 2002, p.157). Environmental education in European Union countries is given more space within the education programs whereas recent studies in Turkey carried out on students in primary and secondary education levels in Turkey have revealed that the education system in Turkey gives less space to environmental issues (Arkış, 1992; Doğan, 1993; Kunt & Geçgel, 2013; Ozaner, 2004; Soran, Morgil, Yücel, Atav, & Işık 2000; Tanriverdi, 2009; Tican, 1996; Yilmaz et al., 2002). It has also been stated that not every environmental education is able to provide individuals with sufficient levels of awareness and positive attitudes against environmental issues (Aydın, Şahin & Korkmaz, 2013). For this reason, with respect to how education should be conducted, Saraç and Kan (2015) suggest that during environmental education process, educators "must provide children with sufficient information, develop the sense of adoption towards environment, provide sufficient amount of materials, develop incentive actions and embody the results of the implementation and give feedback about the values and judgments related to the environment" (p. 143) with suggestions on how environmental education can be conducted. However, Yücel and Morgil (1998) emphasized that the education to be given about the environmental issues should start with preschool period and should be gradually added to the education programs. As a consequence of such efforts, it is believed that it is possible to raise a more environmentally-friendly generation which is also more conscious towards environmental issues (Kunt & Geçgel, 2013; Ozaner, 2004; Saraç & Kan, 2015; Soran et al., 2000; Tanrıverdi, 2009: Tican, 1996; Yılmaz et al. 2002). However, in a study examining the environmentalist attitudes of preservice teachers studying at the faculty of education (Aydın et al., 2013), it was found that environmental attitude scores of preservice preschool teachers were lower when compared to preservice science teachers and elementary teachers. This outcome is thought to be due to the fact that preschool teacher education programs have less space the environmental education than others.

In a study by Altunoğlu and Atav (2009), the researchers asserted that people cause the environment to change and deteriorate through their own actions, as a result of which they will face the danger that may arise from such destruction, and they also emphasize that the main reason of environmental problems are people themselves. In similar studies, researchers have expressed that environmental issues are caused by the way people live and their value judgments, and emphasized the importance of environmental education to prevent environmental issues (Çepel, 2003; Daştan, 1999; Gökçe, Kaya, Aktay & Özden, 2007; Teksöz et.al., 2010; Uzun & Sağlam, 2007). Based on such views, it can be asserted that schools have a great responsibility for raising awareness and informing individuals about how to solve environmental issues (Yalçınkaya, 2012). Similarly, Demir and Yalçın (2014) have stated in their study that it can be of great help to raise awareness about environmental issues when individuals are given proper education at schools about how to prevent environmental issues, as a result of which they will learn about the natural environment and how to use natural resources in an efficient and balanced way.

However, Demir and Yalçın (2014) have emphasized the necessity of taking actions for environmental issues on the basis of "gradually increasing population growth in the world, the rapid depletion and pollution of natural resources, the spread of industrial and technological diversity, the necessity of increasing and maintaining the measures on environmental issues..." (p.18). In another study, Yılmaz and Arslan (2011) have stated that countries have different responsibilities in protecting the environment, that the state takes more responsibility for environmental issues in developed countries, while this responsibility falls more on people in developing countries. From this point of view, it can be said that there are many responsibilities both for the communities and individuals as well as schools in taking actions for environmental issues. In addition, researchers have emphasized the importance of environmental education which should start with preschool period by emphasizing that raising environmentally-friendly and conscious individuals towards the environment and environmental problems starting from the preschool period and continuing during the primary and secondary education is the most important step (Gülay & Ekici 2010; Kolomuç & Açışlı, 2013; Kunt & Geçgel, 2013; Metin, 2010; Özden, 2008; Şimşekli, 2004, Yücel & Morgil, 1998). For this reason, study group of preservice preschool teachers who constitute the first and most important stage of the education were included as the participants of this study. That is why, the current study was important for field and society to see what knows of our children's future teachers about environmental problems and solutions. This study could be showing also necessities of early childhood teacher education programs for improving preservice teachers' knowledge about environment. It is therefore, this study aimed to investigation the extent of awareness of preservice preschool teachers studying at a faculty of education in Turkey, where environmental issues have been experienced in a very intensive way. In line with the purpose of the study, the research question is defined as 'What are the views of preservice preschool teachers on environmental problems and their suggestions of solution?'

Method

Research Design

Case study method typically combines numbers of data collection technique (Eisenhardt, 1989) and explains and understands the dynamics of a contemporary phenomenon (Çepni, 2009; Yin, 2011). Case study research method was used in this study, which aims to identify the opinions of the preservice preschool teachers on environmental problems and possible solutions, in order to identify the individual perceptions and opinions of the participants directly towards environmental issues, as well as to understand and explain the current situations. Case studies generally aimed to explain deeply cases in its real condition (Yıldırım & Şimşek, 2013). From this perspective, different codes and themes were formed for the answers of preservice preschool teachers' when asked about environmental issues and possible solutions, through which the perceptions and opinions of the participants were tried to be identified.

Study Group

In the qualitative studies, it is stated that the large sample size does not mean that more information will be collected, and consequently, sampling should be in the form of purposeful sampling and made without any randomization and within this context (Baş & Akturan, 2008). Based on this, the study group was appointed with the purposeful sampling model and the working was composed of participants based on volunteering. The study group of this study consisted of 62 (54 female and 8 male) preservice teachers (PT) who were senior at preschool education program in one of the state universities in the South-eastern Anatolia region.

Data Collection Tool

With the aim of identifying preservice preschool teachers' views on environmental issues and solutions, an interview form with eight semi-structured open-ended questions was prepared. The opinions of the relevant field experts (in the field of environmental education, in the field of science education, in the field of preschool science education and in the field of language education) were taken while creating the interview questions, and the content validity and language validity of the interview questions were provided. As a pilot implementation, the questions in the interview form were administered to five preschool teacher candidates who were not included in the study, and their opinions were recorded and the comprehensibility of the questions was checked. In the interview form, there are two questions about environmental issues in accordance with the purpose of the study, one question about the sources of environmental issues, one question about the results of environmental issues and how to solve environmental issues and the responsibilities of individuals, society and school in this regard. The questions were asked to the preservice preschool teachers and their answers were recorded with a voice recorder.

Data Analysis

Creswell (2007) has stated that the data transferred to the electronic environment in the data analysis process should be separated into important concepts, sentences and quotations in order to reveal how the participants perceive the relevant phenomena. The answers given by the preservice teachers to the questions were transferred to the electronic environment and content analysis was made with the NVivo11 program. In this study, the answers of the participants to each question were analysed by the paying attention to case study research method. Furthermore, it is emphasized that the data similar to each other should be brought together within the framework of certain codes and themes in order to organize the data in a more understandable manner (Yıldırım & Şimşek, 2013). From this point of view, important and common expressions taken from preservice teachers were classified, structural and tactile descriptions were collected under different codes, and percentage (%) and frequency (*f*) calculations were made. With these percentage and frequency distributions, it was aimed to explain the opinions of preservice preschool teachers about the subject matter in more detail and in depth.

Results

The demographic information of the participants shows that the majority of preservice preschool teacher are female (87.1%) and graduated from Girls' Vocational High Schools (45.2%), and the rest of them graduated from Anatolian High Schools (27.4%) and General High Schools (22.6%). The mothers of the preservice teachers were mostly primary school graduates (61.3%) and their fathers were mostly primary school (40.4%) and high school graduates (29.0%). Similarly, in terms of occupation, it is seen that the majority of mothers were housewives (85.5%) and fathers were mostly self-employed (32.3%), unemployed (25.8%) and civil servants (20.9%). According to the family residence status, it was found that pre-service teachers mostly lived in provinces (69.4%) and districts (20.9%).

In addition, the majority of preservice teachers (67.8%) in the study did not take any environmental courses during their education and almost half of them did not participate in any environmental activities. In Turkey, there are some classes which related with environment and environmental issues from K-12. However, literacy related with environment is nominal in Turkish science textbooks. That is why, student has lower skills toward protecting and understanding environmental skills (Pektas, Altunoglu, & Eksi, 2013). However, in universities, the environmental education classes were depending on the majors. For example, in the early childhood teacher education program of the preservice teachers who participated in current study offer one environmental classes as a selective class. Even if this class is a selective class, there are some limitations to select that class such as number of students who can take class. In this, they may have chance to learnt what is the environmental issues, how they can be solve, what are the schools, teachers, and children' role. In addition, it was found that the majority of preservice teachers (88.8%) did not have any membership in any environmental non-governmental organizations (NGO).

The preservice preschool teachers' views on global-scale environmental problems were analysed with content analysis and the results are shown in Table 1.

Table 1. *Preservice Preschool Teachers' Views on Global-Scale Environmental Problems*

Theme	Codes	*f*	%
Global-Scale Environmental Issues	Global warming	19	20.65
	Air, water and soil pollution	15	16.30
	Release of chemical waste into the environment	8	8.70
	Extinction of animal species	7	7.61
	Environmental pollution	6	6.52
	Destruction of the ozone layer	4	4.35
	Industrialization	3	3.26
	Noise pollution	3	3.26
	Drought	3	3.26
	Climate changes	3	3.26
	Globalization	2	2.17
	Visual pollution	1	1.09
	Nuclear power plants	1	1.09
	Epidemics	1	1.09
	I don't know	16	17.39

Table 1 shows that the majority of the preservice preschool teachers considered global warming as the major (20.65%) environmental problem, and very few (1.09%) regard epidemics, nuclear power plants and visual pollution as the major issues. In addition, some of the preservice teachers (16.30%) indicated air, water and soil pollution as the bases of global-scale environmental problem, and some (17.39%) did not express any opinion on global environmental problems. However, it was identified that preservice teachers also had different opinions about global-scale environmental issues (industrialization, environmental pollution, noise pollution, release of chemical wastes into the nature, etc.). The examples of some preservice teachers' opinions related to global-scale problems are as follows:

> *PT7: "Disruption of the natural balance of the universe as a result of water and air pollution caused by global problems."*

> *PT18: "Global warming, ozone depletion, extinction of living beings and species."*

> *PT59: "Global warming, environmental pollution, extinction of species."*

The results of the content analysis on preschool teachers' opinions on environmental problems in Turkey are given in Table 2.

Table 2. *Preservice Preschool Teachers' Views on Environmental Issues in Turkey*

Theme	Codes	f	%
Environmental Issues in Turkey	Air, water and soil pollution	37	29.84
	Environmental pollution	27	21.77
	Chemical wastes	18	14.52
	Noise pollution	15	12.10
	Unplanned urbanization	7	5.65
	Deforestation	7	5.65
	Lack of consciousness on environmental pollution	4	3.23
	Cosmetics	2	5.85
	Unconscious consumption	1	0.81
	Drought	1	0.81
	Artificial products	1	0.81
	I don't know	4	3.23
	Nuclear power plants	1	1.09
	Epidemics	1	1.09
	I don't know	16	17.39

According to the data given in Table 2, the majority of preservice preschool teachers surveyed (29.84%) expressed that the biggest environmental problem in Turkey was air, water and soil pollution. In addition, others (21.77%) expressed that the biggest environmental problem in Turkey was environmental pollution. Among many different views, one of the preservice teachers (0.81%) considered artificial products while the other one (0.81%) considered drought as the main source of environmental issues in Turkey. The issues about chemical waste (14.52%) and noise pollution (12.10%) were also among the attention-taking opinions of other teachers. In addition, very few teachers (3.23%) were found to have no opinions with regard to environmental problems in Turkey. The examples of some preservice teachers' opinions to environmental problems in Turkey are as follows:

> *PT16: "Factory waste, food and beverage wastes."*

> *PT18: "False planning, lack of environmental awareness, improper disposal of waste, destruction of existing woodland and recreation areas."*

> *PT25: "Release of heavy metals into water, release of domestic waste, unconsciousness."*

The preservice preschool teachers' opinions on the reasons of environmental problems were analysed with content analysis and the results are shown in Table 3.

Table 3. *Preservice Preschool Teachers' Views on the Reasons of Environmental Problems*

Theme	Codes	f	%
Reasons of Environmental Issues	Humans	50	64.92
	Lack of education	9	11.69
	Industrialization	4	5.19
	Unconscious use of natural resources	2	2.60
	Chemical wastes	2	2.60
	Administrators	2	2.60
	Living and non-living things	1	1.30
	Unplanned urbanization	1	1.30
	Air, water and soil pollution	1	1.30
	Global warming	1	1.30
	Globalization	1	1.30
	Hazardous chemical gases	1	1.30
	I don't know	2	2.60
	Epidemics	1	1.09
	I don't know	16	17.39

According to the data in Table 3, the majority of preservice preschool teachers (64.92%) who participated in the study stated that the reason of environmental problems was people. However, some of them (11.69%) stated that lack of education and very few (5.19%) stated that industrialization was the main reason. Besides this, other opinions of the preservice teachers on the reasons of environmental problems were related to chemical waste, global warming, administrators, unconscious, and use of natural resources. The examples of some preservice teachers' opinions about the reasons of environmental problems are as follows:

> *PT9: "Unconsciousness of people, misuse of environment, increased human population."*

> *PT14: "Unconsciousness about the environment, inefficient education."*

> *PT24: "Unconscious deeds of humans, failing to pay attention towards the environment."*

The preservice preschool teachers' opinions on the possible results of environmental pollution were analysed with content analysis and the results are shown in Table 4.

According to the results in Table 4, the majority of preservice teachers (16.04%) who participated in the research reported their opinions by saying that "human life will be challenged" and "the natural environment will be damaged" as a result of environmental problems. Other participants (14.6%) stated that "living spaces of living beings will become narrower". In addition, very few of the participants (2.47%) stated their opinions as "I don't know".

Table 4. *Preservice Preschool Teachers' Views on the Results of Environmental Pollution*

Theme	Codes	*f*	%
Results of Environmental Pollution	Natural environment will be damaged	13	16.04
	Human life will be challenged	13	16.04
	Living space of living beings will become narrower	12	14.60
	Living beings will become extinct	11	14.00
	Diseases will appear	11	14.00
	Global warming will occur	9	11.10
	Environmental pollution will occur	6	7.41
	Natural resources will run out	4	4.80
	I don't know	2	2.47

The examples of some preservice teachers' opinions on what could be the result of environmental pollution are as follows:

PT8: "Natural balance will deteriorate, oxygen in the air will become contaminated, human health will be greatly damaged."

PT10: "The glaciers will melt, the ozone layer will be depleted, some diseases will become widespread, living things will be greatly damaged."

PT20: "Natural resources will be exhausted, humans and other living beings as well as life will be negatively affected and even endangered."

The preservice preschool teachers' opinions about how to solve environmental problems were analysed with content analysis and the results are shown in Table 5.

According to the data in Table 5, the majority of preservice teachers (52.56%) who participated in the research believe that environmental problems can be solved by "raising people's awareness". In addition, some of the participants (21.79%) believed that environmental problems could be solved by "educating people about this issue". However, very few of the participants (1.28%) expressed their ways towards "creating campaigns on the environment", "no solution", and "becoming a producing society rather than a consuming society". In addition, some of the participants (6,41%) had no idea how to solve the environmental problems. The examples of some preservice teachers' opinions on how to solve environmental problems are as follows:

PT8: "With the cooperation of organizations and people supporting the environment."

PT14: "Through raising people's awareness, supporting them with adequate level of education, and planned settlements."

PT20: "It can be solved by not ignoring any cases that disrupt the biological balance, and taking actions against them, though they are trivial."

The preservice preschool teachers' opinions about the responsibilities of individuals towards protecting environment were analysed with content analysis and the results are shown in Table 6.

Table 5. *Preservice Preschool Teachers' Opinions on How to Solve Environmental Problems*

Theme	Codes	*f*	%
Solutions to Environmental Issues	Through raising people's awareness	41	52.56
	Through educating people about the issue	17	21.79
	Through the work of administrators on environmental issues	4	5.12
	Through imposing sanctions on the environmental issues	3	3.84
	Through establishing chemical waste depots and establishing treatment plants	3	3.84
	Through the cooperation of environmental organizations and people	2	2.56
	Through creating campaigns on the environment	1	1.28
	No solution	1	1.28
	Through becoming a producing society rather than a consuming society	1	1.28
	I don't know	5	6.41

Table 6. *Preservice Preschool Teachers' Opinions on the Duties of Individuals in Protecting the Environment*

Theme	Codes	*f*	%
Duties of Individuals in Protecting the Environment	Being conscious about environmental protection	20	23.54
	Being responsible individuals	16	18.82
	Paying attention to environmental cleaning	13	15.29
	Protecting one's own environment	8	9.41
	Being sensitive about environmental protection	7	8.24
	Helping protect the environment	5	5.88
	Planting trees	3	3.53
	Not harming living beings and plants	2	2.35
	Protecting natural resources	2	2.35
	Developing empathy	2	2.35
	Receiving training about environmental protection	1	1.18
	Anything can be done	1	1.18
	I don't know	5	5.88

According to the data in Table 6, the majority (23.54%) of preservice teachers who participated in the study stated an individual's duty as "being conscious about environmental protection", while some of them (18.82%) expressed their opinions as "being responsible individuals". Very few participants (1.18%) expressed their views as "anything can be done" and "receiving training on environmental protection". Also, some of the participants (5.88%) did not express any opinions about this topic. The examples of some preservice teachers' opinions on the duties of individuals in protecting the environment are as follows:

PT2: "Receiving trainings on environmental protection and sharing this knowledge with the others."

PT5: "At first, the individual himself must not harm the environment, and must not let others pollute it."

PT32: "As conscious individuals, we must first recognize our responsibility for the natural cycle of natural life."

The preservice preschool teachers' opinions about the responsibilities of the schools towards protecting environment were analysed with content analysis and the results are shown in Table 7.

Table 7. *Preservice Preschool Teachers' Opinions on the Duties of Schools in Protecting the Environment*

Theme	Codes	*f*	%
Duties of Schools in Environmental Protection	Providing education	30	38.46
	Raising environmentally friendly individuals	24	30.77
	Being role models for students	6	7.69
	Carrying out social club activities about the environment	5	6.42
	Imposing sanctions for environmental protection	2	2.56
	Creating environmental responsibility in children	2	2.56
	Creating cleanliness habits	1	1.28
	I don't know	8	10.26

According to the data in Table 7, the majority (38.46%) of the preservice teachers who participated in the study stated their opinions about the main duty of schools about environmental protection as "creating environmental responsibility in children", while some others (30.77%) expressed their views towards "raising environmentally friendly individuals". In this respect, very few (1.28%) of the participants' opinions about the duties of the schools were identified as "creating cleanliness habits". In addition, some of the participants (10.26%) answered as 'I don't know'. The examples of some preservice teachers' opinions on the duties of schools in protecting the environment are as follows:

PT29: "Creating an understanding in children towards the importance of the environment, and teaching them how to save."

PT34: "Providing children with necessary training starting from primary school."

PT38: "Awareness-raising activities can be conducted for students."

The preservice preschool teachers' opinions about the responsibilities of the society towards protecting the environment were analysed with content analysis and the results are shown in Table 8

According to the data in Table 8, the majority (23.82%) of preservice preschool teachers who participated in the study stated their opinions about the duties of the society as "being conscious about the environment". Very few of the participants (1.19%) stated their opinion as "planting trees". However, some of the participants (15.48%) did not have any idea about this issue. The examples of some preservice teachers' opinions on the duties of the society in protecting the environment are as follows.

PT13: "Raising awareness of individuals about environmental protection."

PT40: "Increasing the number of non-governmental organizations in the field of environmental protection and continuous activities conducted by such organizations."

PT58: "Raising educated individuals and being conscious."

Table 8. *Preservice Preschool Teachers' Opinions on the Duties of the Society in Protecting the Environment*

Theme	Codes	*f*	%
Duties of Individuals in Protecting the Environment	Being conscious about the environment	20	23.82
	Being responsible for the protection of the environment	10	11.90
	Protecting the environment	8	9.53
	Being informed about how to protect the environment	5	5.95
	Increasing participation in environmental organizations	5	5.95
	Imposing sanctions on those harming the environment	5	5.95
	Fulfilling one's own individual responsibilities for the environment	4	4.76
	Protecting natural resources	4	4.76
	Being a role model for children to protect the environment	3	3.57
	Being sensitive for environmental protection	3	3.57
	Being sensitive towards the environment	3	3.57
	Planting trees	1	1.19
	I don't know	13	15.48

Conclusion, Discussion and Suggestions

This study was carried out according to case study design within the scope of qualitative research methodology in order to reveal preservice preschool teachers' opinions about environmental problems and possible suggestions of solution.

The fact that the biggest feature of environmental issues is that they are at a global basis requires teachers and preservice teachers to be more sensitive to the global environmental problems. As an example of global environmental problems, researchers emphasize the rapid population growth in the world, decreasing natural resources, industrialization and unplanned urbanization (Şenyurt, et al., 2011). In the studies conducted with university students, global warming is observed to be at the first place among global scale environmental problems, air pollution is the second, and then comes the use of natural resources (Altın, Bancanlı, & Yıldız, 2002; Aydın & Kaya, 2011; Aydoğdu & Gezer, 2006; Erol, 2005; Harris, 2012). Similar results were obtained in the current study and it was found that preservice teachers expressed global warming as the biggest global environmental problem and then came air, water and soil pollution. Additionally, in this study, it was identified that preschool teachers considered the release of chemical waste into the nature and the extinction of various animal species as another global environmental problem. Probably, the perspectives of the university students were impact from their social life, using technology, and academic awareness as teacher. Being a conscious person help them to build their teacher characters. In addition, preservice teachers have chance to social acceptability when they have thoughts about environmental problems and being a conscious for environment.

Researchers state that the most effective method for solving the problem of environmental pollution is the trainings to be conducted in this subject matter (Erten, 2005; Kesicioğlu & Alisinanoğlu, 2009; Ozaner, 2004; Saraç & Kan, 2015). Given the studies conducted in Turkey and in other European countries on the extent of attention paid to environmental education included in the educational systems, researchers have stated that not enough education is given in Turkey with this respect to the environment when compared to the education programs of other European Union countries (Arkış, 1992; Dogan, 1993; Kunt & Geçgel , 2013; Ozaner, 2004; Yılmaz et al., 2002). As a result of this situation, it is thought that, unless the measures are taken with the education, the global environmental problems will be experienced in different ways in Turkey such as the reduction of natural resources, air, water and soil pollution, and chemical wastes. In this study, preschool teachers were observed to state air, water and soil pollution, environmental pollution, chemical wastes and noise pollution as the biggest environmental problems in Turkey. In the study conducted by Polat and Bahar (2012), problems such as environmental pollution (wastes), air, water and soil pollution are mentioned as major environmental problems which seen in Turkey. In addition, Şenyurt et al., (2011), in their study conducted with university students, stated that the majority of students considered environmental pollution and hazardous industrial wastes as the most important environmental problems in their region. Unlike other studies, this study reported that preschool teachers indicated noise pollution as one of the other important environmental problem was seen in Turkey. The reasons of these differences were probably about preservice teachers' majors. For instance, Yılmaz et al. (2002) studied with university students who study in Chemistry. That's why the students mostly stated as perspectives of chemist to environmental problems. However, in the current study, preservice early childhood teachers stated their perspectives as a kindergarten teacher which mostly they will be seen in their work noisy.

The fact that environmental problems have become a threat to the natural life and humanity have revealed the vital importance of these problems (Şenyurt et al., 2011). In this case, it is necessary to know what can be the reason of environmental problems in order to solve them. In a study by Altunoğlu and Atav (2009), the researchers have asserted that people cause environmental deterioration and change, and they themselves are faced with the danger as a result of their own activities, and that the main reason of environmental problems is people. In addition, researchers have emphasized that people's lifestyles and value judgments are the main causes of environmental problems, and that individuals' participation in trainings about environmental issues and in environmental activities are of great importance in creating the necessary atmosphere for the solution of environmental problems (Çepel, 2003; Daştan, 1999; Gökçe, Kaya, Aktay & Özden, 2007; Kunt & Geçgel, 2013; Ozaner, 2004; Teksöz et.al., 2010; Uzun & Sağlam, 2007). Similar to the results of previous studies on the reasons of environmental problems, the results of this study showed that preservice teachers considered people as the main reason of environmental problems. Demir and Yalçın (2014), in their study, have stated that the trainings at schools on environmental problems will enable people to know about the natural environment in which an individual reside, learn how to use natural resources efficiently and in a balanced way, which will help raise awareness about environmental problems. It has been emphasized that preservice preschool teachers who will conduct preschool education which is the most basic step of education in this subject, should have environmental sensitivity and show the sensitivity required to raise awareness of students (Yücel & Morgil, 1998).

In addition, a number of studies in the literature have indicated that the main reason of environmental problems is people, and thus the most affected group will again be people and other natural areas (Erol & Gezer, 2006; Taştepe & Aral, 2014). Genç and Genç (2013) have stated that environmental problems negatively affected both human life and natural balance. In this study, the majority of preservice preschool teachers stated that human life would become harder as a result of environmental pollution, the natural environment would be harmed, the living spaces of the living beings would be narrowed and the diseases would occur. Similarly, Erten (2005) stated that not only human existence would be threatened, but also the world would become uninhabitable as a result of environmental problems.

Attitudes and behaviors or habits of people lie on the basis of environmental problems. Therefore, the attitudes, behaviors and habits of people can help solve the environmental problems if they are made positive by environmental education. Thus, individuals have an important role to get rid of environmental problems (Teksöz et al., 2010; Uzun & Sağlam, 2007). Erten (2007) has stated that people who are the main actors of environmental problems should be aware of this issue. It is, therefore, obvious that education is important to solve and prevent environmental problems by informing individuals about the environmental issues and creating positive attitudes (Erten, 2005; Saraç & Kan, 2015; Şenyurt et al., 2011). In the current study, it was found that the majority of the participants stated that individuals should be conscious about the solution of environmental problems and that they should be provided with training on the environment and environmental problems. The reason of their perspectives on the solving environment problems by educating people are their major. They believe that probably because of their major's impact on their perspectives as preservice early childhood teachers. Hence, early childhood teachers take several courses and practices for how they can affect a child life by the giving quality education. They also have chances to see child's physical and emotional changes during education. It is therefore, they stated power of education in human life.

In the literature, it has been stated that schools and non-governmental organizations have great responsibilities to train individuals and develop positive attitudes in order to prevent environmental problems and ensure the effective solution. In addition, it was emphasized that the most important duty of schools for prevention of environmental problems is the education of individuals (Aydın, Şahin & Korkmaz, 2013; Çepel, 2003; Daştan, 1999; Erten, 2003; Şenyurt et al., 2011; Yalçınkaya, 2012; Yılmaz et al., 2002). In a study by Yücel and Morgil (1998), conducted with university students, the researchers have stated that universities should held activities such as symposiums, panels, conferences and congresses, that they should help raise awareness of people and students, and should be in cooperation with the industry. Similarly, in the current study, it was found out that the preservice teachers stated that the greatest duty of schools in protecting the environment should be educating and then raising awareness of individuals. Likewise, Şenyurt et al. (2011) stated that higher education institutions should conduct scientific research in the field of environmental protection and prevention of environmental problems and raise academicians who are sensitive to environmental problems.

The scarcity of natural resources and energy resources and increased pollution due to the rapid population growth, urbanization and industrialization are the main environmental problems. Researchers have indicated that the greatest duty of the society is to ensure environmental awareness and that social participation is necessary for the sake of environmental protection (Kunt & Geçgel, 2013; Şenyurt et al., 2011). Yücel and Morgil (1998) have asserted that the society should be more aware of the environmental problems. However, Kunt and Geçgel (2013) have stated that the legal measures taken by the governments in the solution of the environmental problems that arise in the global level and the knowledge acquired within the family and social environment are not enough. Likewise, in the current study, it was found out that preservice preschool teachers expressed the necessity of being conscious of the environment as a society and taking responsibility as a society for the protection of the environment.

As a result, the current study aimed to investigate the views of preservice preschool teachers on the environmental issues and how to overcome these problems, and it was found that the opinions of preservice teachers were similar to the results of previous studies on this subject. Based on the results of the study, it is suggested that both theoretical and applied courses related to environmental education must be involved in the curriculum of preschool teaching programs so that preservice preschool teachers, who will educate the future individuals, can be supported in such a way that they could become more sensitive about environmental issues and environmental protection. Especially by the having some course about environment, they may have improved their knowledge about global environmental issues, how those can be solved, and roles of schools on these positions. In addition, by the encouraging preservice early childhood teachers to participate NGO's about environment, they may chance to learn what the environmental problems they have seen are and how they can solve these problems, and educate children as conscious people about environmental problems. Having more courses and also practices should be help preservice teachers to improve their knowledge about environment and environmental problems. İt is necessary because most of the preservice teachers had lack of knowledge on the reasons and results of environmental problems. Consequently, they had similar solutions for environmental problems. Additionally, both schools and non-governmental organizations should work more and develop the sensitivity of individuals towards environmental problems in order to raise conscious individuals. In order to protect the environment and to prevent problems, more activities should be arranged for environmental education in order to raise environmentally-friendly individuals starting from preschool period.

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An Investigation on the Relationship between Reading Fluency and Level of Reading Comprehension According to the Type of Texts

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Abstract

The purpose of this study is to investigate the relationship between the reading fluency and the reading comprehension in accordance with the type of the text. Participants of the study are 99 students who were chosen among fifth graders in a Turkish secondary school. The study utilized descriptive analysis and adopted predictive correlational research design. "Reading Comprehension Test" and "Multidimensional Reading Scale" were used as data-collection tools. According to findings; while the speed of reading, percentage of word recognition, and prosodies differed in favour of narrative texts, there was no significant difference in regard to the level of the reading comprehension. When checked for the magnitude of impacts, the significant difference in the percentage of the word recognition was found small (r= .18), the significant difference in the reading speed was large (d= 1.02), and significant difference in prosody was in the middle (d= .75). It has been found that the reading fluency elements (prosody, accuracy, and reading speed) have a significant positive relationship and a similar relationship can also be seen along the lines of the reading comprehension in different types of texts in each type of the text. Furthermore, the study has stated that speed of the reading and prosodic values can be predictors of the reading comprehension percentage on a significant level in the informative and narrative text types. The findings of this study were consistent with the literature provided by the study.

Keywords: Reading Fluency, Reading Comprehension, Reading Rate, Reading Accuracy, Prosody

Introduction

Reading has kept its prominence of being a basic skill for learning at every stage of an education process so far. Reading playing a key role in the instruction of all academic skills has a predictive feature concerning academic performances of students (Güldenoğlu, Kargın, & Ergül, 2016). There are basic ingredients which are necessary for the improvement and the succession of reading skill. The National Reading Panel [NRP] (2000) has accepted the reading fluency as one of the five critical elements of the reading. The reason behind this acception is that it constructs a way for the reading comprehension. Reading fluency skills have been accepted as prerequisites for the achievement of the reading comprehension by many researchers in the field of the reading (Bastug & Akyol, 2012; Bastug & Keskin, 2012; Ehri, 2005; Fuchs, Fuchs, Hosp, & Jenkıns, 2001; Keskin, 2012; Keskin & Bastug, 2013; Pikulski & Chard, 2005; Rasinski, 2010; Samuels, 1979; Yıldırım, 2010; Yıldırım & Rasinski, 2014). Three basic components of reading fluency are speed, prosody, and accuracy (Rasinski, 2010). Reading speed is accepted as one of the elements of the automaticity (Akyol, Yıldırım, Ates, Cetinkaya, & Rasinski, 2014). Automaticity is a theory procuring assumptions regarding the transformation from apprenticeship to mastership. The first assumption is based on the idea that the human brain has a limited capacity for conducting difficult tasks while the second assumption is that the mind consumes energy to accomplish these difficult tasks and this energy consumes the limited capacity. The third assumption is that the necessary effort for accomplishment of the difficult tasks is reduced through application. Lastly, when the necessary effort has been reduced to a sufficient level, one is able to conduct another task (Rasinski, 2010, 2014). When the theory of the automaticity is adapted to the reading skill, the picture is as follows: for an individual to achieve the skill of the comprehension that is the aim of the reading, it is necessary he/she is in possession of certain circumstances. One of them is the word recognition. When a reader lacks the necessary ability of quick analysis, the task of reading shall be a "difficult task" for him/her and therefore his/her mind will consume energy. However, since analysis will become easier as one reads more and more, the energy necessary for analysis will diminish and one will be able to take on a new task. This implies the ability for the individual to reserve his/her mental capacity for the reading comprehension (Adams, 1990; LaBerge & Samuels, 1974; Rasinski, 2010). The theory of the automaticity emphasizes the reservation of one's mental capacity for comprehension through explanation of the features of the reading fluency: the reading accuracy, and the reading speed.

The percentage of the word recognition is the rate of the accurate reading of the text. When mistakes are made at a certain level, the level of the comprehension decrease. For this reason, it is an important element of comprehension skill for the readers to make as less mistakes as possible. Akyol et al. (2014) and Rasinski (2010) have stated that the reading accuracy rates between 92% and 98% can be considered as an instructional level while the reading accuracy rates above 98% are considered as an independent reading level. Those below these intervals are considered as a concerning level and the students at this level are accepted in need of an assistance to read.

Confining the reading fluency as an automaticity process that occures after repeated reading is not a correct approach either. This understanding reduces the reading fluency to only accurate vocalization and fast reading. While reading correctly is one of the main components of the reading fluency, it is not limited to this only. The speed of reading in accordance with comprehension and prosodic reading, which are skills evolved after this basic skill construct the way to reading comprehension.

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A prosodic reading is called reflection of the emotions and thoughts of the writer to the reading by paying attention to the meaning groups, punctuation marks, emphasis, and tone (Zutell & Rasinski, 1991). In other words, prosodic reading is when the meaning of the text comes to life when the text finds voice. A student's reading prosody is a good indication that he/she has a fast and accurate reading ability (Schwanenflugel, Hamilton, Kuhn, Wisenbaker, & Stahl, 2004). If a child reads with expression, one can be sure that he/she has achieved the reading fluency (Schwanenflugel & Ruston, 2008). Some studies depict that there is a positive relationship between prosodic reading and reading comprehension (Dowhower, 1991; Kitzen, 2001; Kuhn & Stahl, 2000; Rasinski, 2004).

It is noteworthy that the reading fluency is particularly related to academic achievement and test-scores. Many studies have focused on this issue and revealed some significant findings. Hunley, Davies, and Miller (2013), for instance, have pointed out that there is a strong relationship between the reading fluency and statewide reading success. Nunez (2009) has also arrived in a similar conclusion. Nunez (2009) found a strong relationship between the test performance and the reading fluency skills in the "Texas Assessment of Knowledge and Skills" test. A number of similar studies have shown the influence of the reading fluency on the level of success in examinations. It is known that children who are not yet fluent can suffer from many difficulties if they cannot succeed in these exams.

The reading fluency is just one of the many variables that are necessary for comprehension, as well as being a bridge for reading comprehension. Other factors such as vocabulary, world knowledge, and inferencing abilities are also important for the reading comprehension (Schwanenflugel et al., 2006). Understanding a text is a complicated process. This process requires participation of different characters, different types of information, and complex mental representations (Rawson & Kintsch, 2005). The acquisition of basic skills in this fairly complicated process is important for achieving the ultimate goal of reading, which is comprehension.

Another variable that plays an important part in the construction of the reading comprehension is the interaction between the reader and the text (NRP, 2000; Reading Study Group, 2002). In this interaction, the type and the structure of the text are influential, as well as the the reading fluency skills that the reader must possess. Yıldırım et al. (2010) found that text types are important factors affecting the comprehension of the text. The familiarity with the structure of the text has an effect on the outcome. The more frequent encounter of students with stories and tales starting from pre-school leads them to be more aware of narrative texts, which affects their reading comprehension in a positive manner. Studying with mostly narrative texts in the pre-literacy period and in the early stage of the school years makes this text easier to understand. Thus, it is clear that studies have concluded with similar outcomes. A research on the fifth grade students conducted by Yıldız (2008), Sidekli, and Buluç (2006) and the study on the eighth grade students of Temizyürek (2008) have detected that students understand narrative texts better than the informative texts. Text type, which is an important variable on understanding, is also an effective factor on the reading fluency (Hiebert, 2006; Rasinski, 2006). The course of content and dialogues contained within the narrative text brings forward meaningful and expressional reading, having an influence on the prosodic reading. Based on the structure of the texts and the topics that are processed, it is seen that the prosodic scores are higher in the narrative texts. Also in this research, when the distribution of prosodic scores is examined it can be seen that students have lower scores in informative texts.

Acquisition of the fluency is not only an indicator of the reading comprehension while reading out loud, but also an important necessity for the reading comprehension in silent reading (Cetinkaya, Ates, & Yıldırım, 2016; Gross, Millett, Bartek, Bredell, & Winegard, 2013; Kuhn, Schwanenflugel, & Meisinger, 2010). The silent reading of students who cannot read fluently is also challenging. These children can experience serious difficulties in both understanding and learning the text, developing a negative attitude towards reading because of the difficulty they have experienced whilst reading. Because of their reluctance to read, they are deprived of the richness offered by the reading. It is essential to determine whether a student has a fluency problem at their early ages, as it may be a preliminary symptom of a number of prospective undesired situations (Schwanenflugel and Ruston, 2008). Since the reading comprehension dominates academic life, this determination and subsequent interventions are important for students to be successful in their academic endeavours. It is highly unlikely to expect that students with understanding problems of what they read to be successful in nation-wide exams. Understanding texts is not only related with language education courses but also with mathematics (Özdemir and Sertsöz, 2006; Yılmaz, 2011), science (Obalı, 2009; Yılmaz, 2011), and social studies lessons (Yılmaz, 2011). By solving these issues, therefore, children with comprehension problems can be led to be more successful in their academical life.

Purpose of the Study and Methodology

The purpose of this study is to examine the relationship between the reading fluency components and the reading comprehension.

Research Questions:

The main research question of the study is structured as "There is the relationship between the the reading fluency and the reading comprehension in the informative and narrative texts of the fifth grade middle school students?"
The sub-questions are as follows:

1. Do reading fluency skills (reading speed, prosody, and accuracy) of the fifth grade students show a significant difference according to the text type?

2. Does the comprehension percentage of the fifth graders differ significantly based on the type of the text?

3. There is the relationship between reading fluency skills across and within different types of texts occured?

4. There is the relationship between the reading fluency skills and the reading comprehension percentages in different types of the texts and the mean reading comprehension percentage correlated?

5. Do the reading fluency skills (reading speed and prosody) predict comprehension abilities based on the type of text in a meaningful matter?

Methodology

Predictive correlational research design and descriptive statistics were used in this study to examine the relationship between the components of the reading fluency and comprehension skills of the fifth grade students in a Turkish middle school. A correlational study was conducted to examine the relationships between two or more variables without any intervention (Gürbüz & Şahin, 2016). Descriptive analysis was implemented to examine the main features of the dataset (Fraenkel, Wallen, & Hyun, 2012).

Study Group

This research was conducted in a middle school in Turkey that has pupils who are coming from relatively similar families of average socio-economic levels in Kecioren, one of the central districts of the capital city of Turkey, Ankara. There were ten classes in the fifth grade in the school. It was understood from the e-school notes provided by the school administration that there were no significant differences existed in pupils' academic averages on their Turkish lessons between five different branches of the fifth graders. After a consultation with the school administration and teachers, this research was conducted with students of four classes which were carefully selected from 10 classes in total. Classroom population varied between 22 and 30 students. There were several students in each class who have a special education report. Data was also collected from these students but was not included in the survey. A total of 99 students participated on voluntary basis.

Data Tools and Methods

Reading Comprehension. The Reading Comprehension Test, prepared by the researchers, was adopted to determine the levels of comprehension of the students. The test consisted of two texts: narrative and informative. Six open-ended questions were asked for the informative text, while five were asked for the narrative text. The test preparation process consisted of the following steps:

• Creating a text pool obtained from the Turkish textbooks of the previous years 'curricula and approved by the Turkish Ministry of National Education and the Board for Educational and Disciplinary Affairs.

• Classification of the readability levels of the texts according to Atesman (1997), a readability formula.

• The texts were presented to a group of ten experts formed of some academicians and Turkish teachers to evaluate them in accordance with the "Textuality Criteria Experty Opinion Form" in order to check if these texts are suitable for the textuality criteria Two of the texts that had received highest scores were chosen.

• To determine questionnaires that are suitable for writing questions by evaluating the criteria of being measurable from the fifth grade reading acquisitions of the 2017 Turkish Language Teaching Programme and informative and narrative texts in order to create comprehension questions for selected informative and narrative texts. Preparation of questionnaires for these identified reading achievements. Formation of a pool of 45 items, 20 for the informative text, and 15 for the narrative text.

• Grouping these questions prepared for the achievements into simple understanding (recognition and recall) and in-depth meaning (based on inference and interpretation) (Akyol, 2016).

• Assessment of questionnaires by experts who are trained in the Turkish language in order to determine the scope of the prepared questions. Pilot study with fifth grade students on the draft ten-question reading comprehension test chosen as a result of expert evaluation.

• Identification of five open-ended questionnaires for the narrative text, six for the narrative text, based on the opinions of field experts and the results from the pilot study.

• Preparation of scoring keys to ensure the reliability of the assessment in the reading comprehension test structured as open ended questions.

According to the rubric, simple comprehension questions were scored between the intervals 0-2 while inferential comprehension questions were scored between 0-3. The reading comprehension test for narrative texts were evaluated with a total of five questions: three questions measuring simple comprehension and two measuring inferential comprehension; while the test for the informative texts was evaluated with a total of six questions: three questions measuring simple comprehension and three measuring inferential comprehension. Those who gave a complete answer to the simple comprehension questions were graded 2 points, those who gave quasi-answers were graded 1 point and those who did not give any answer were not graded with any points. Similarly, those who gave a complete answer to the inferential comprehension questions were graded 3 points, those who gave an above-quasi-answer were graded 2 points, those who gave a quasi-answer were graded 1 point and those who did not give any answer were not graded with any points (Akyol, 2016).

In order to ensure the reliability of the evaluation of the reading comprehension questions and provide an unbiased grading, the "Open-Ended Questions Assessment Rubric" was prepared by two experts.

When we look at the coefficient of consistency between the scorers, Cronbach's alpha coefficient was .987 in the informative text, while it was .986 in the narrative text. These values indicate a high level of consistency between the scorers (Garson, 2013).

Reading Fluency. In order to measure the reading fluency, texts were selected in line with expert opinions from a pool of texts that had been previously approved by the Turkish Ministry of National Education and the Board of Education and taught in Turkish classes in recent years. The students read the determined narrative and the informative texts out loud. Approximately two minutes of each student's individual voice recordings were taken and one minute partial assessment was conducted. Reading fluency was based on the reading accuracy percentage, the reading speed, and the reading prosody. A curriculum-based measurement was used for the calculation of percentage of the reading accuracy and the reading speed (Deno, 1985). Since the curriculum-based measurement could only calculate the reading accuracy percentage and reading speed, a special tool designed for measuring prosodic reading was used for the reading prosody. The number of words read in one minute was accepted as the reading speed while the ratio of words read accurately to total number of words read multiplied by 100 was accepted as the accurate reading percentage. "Multidimensional Reading Scale" which was adapted to Turkish by Yıldız, Yıldırım, Ates, and Cetinkaya (2009) developed by Zutell and Rasinski (1991) was used to evaluate the reading prosody. This evaluation scale consists of four dimensions which are expression and sound level, meaning units and intonation, and smoothness and speed. According to the criterion determined on the scale of this evaluation, one student can take at least 4 points and at most 16 points. Recorded audio assisted readings were separately rated by the researchers. The Cronbach's alpha coefficient, which shows the correspondence between the researchers, was in the narrative text, .982; in the informative text, .979. These values indicate that the consistency between the scorers is very high (Garson, 2013).

Data Collection Method

The study data was collected during the last week of the first semester of the academic year of 2017-2018. The implementation of voice recordings and reading comprehension tests was completed in a week. The study data was collected from the fifth graders of a public school located in one of the central districts of Ankara. The necessary permissions for the research were obtained from the Provincial Directorate of National Education of Ankara. The school administration, guidance, and counseling service and the form tutors in the classrooms where data would be collected were provided with detailed information on the content and the purpose of the research. Information was also given to the students who were involved in the proceedings and it was which stressed that the participation of respondents is voluntary. The stady data was collected from all students who volunteered to participate in the study. However the data at hand collected from students who have special education reports was not included in the survey.

As means of the data collection in the survey; The Reading Comprehension Test and the Multidimensional Reading Scale were used. It was ensured that students were in an environment where they feel comfortable during the data collection process. Voice recorders were used during the collection of reading fluency data in the library where the disturbance level was minimum, while the reading comprehension tests took place in the students' own classes. Comprehension tests applied in both types of texts were made in one day apart from one another to care for the student's weariness. A classroom timeframe was given as the exam period. In order to try to minimize the excitement factors of the students while taking the voice recordings, each student was chatted for five minutes before the reading and the possible issues about breathe and excitement controls were tried to be prevented. The reason for doing this is because students seemed nervous when they first arrived to the library, and this nervousness caused them having difficulties controlling their breathing and intensifying their attention. In order to prevent these affecting the reading success, students were chatted before the voice recordings started. It helped them to relax and minimise their nervousness.

Data Analysis

Research findings were explained by using descriptive statistics which summarizes data gathered from multiple units (Fraenkel, Wallen, & Hyun, 2012) .

For the analysis in the study, it was first checked whether data satisfied the normal distribution condition. In both informative and narrative texts, it was seen that the data of the percentages of the word recognition did not have a normal distribution. For this reason, the Wilcoxon signed rank test was used as a non-parametrical alternative to the dependent *t*-test for the comparison of two scores of the same group in terms of percentage of word recognition. Spearman rank differences correlation coefficient was used for looking at the relationship that occured between scores where one part of the data was a percentage of the word recognition.

Although the aim was to use the multiple regression method in looking at the predictive power of text types and the reading fluency skills for the reading comprehension skills, it was not performed because of the normality condition of the data was not satisfied and high correlation was found between the variables (Can, 2017).

In this case, simple linear regression and simple linear correlation to the normal scattering data was applied. The Spearman order differential coefficient was used for the data which did not satisfy the normal distribution assumption and therefore no regression analysis was performed.

Findings

Table 1 presents the descriptive statistics of the values of the reading fluency elements within the framework of the research, which are classified according to the types of texts and their general averages.

Table 1. *Descriptive Statistics Results of the Reading Fluency Values and Means According to the Text Types*

Reading Fluency Components	*n*	*M*	*SD*
Accuracy in Informative Text	99	92.13	8.24
Reading Speed in Informative Text	99	83.08	20.76
Prosody in Informative Text	99	8.46	2.97
Reading Comprehension Percentage in Informative Text	99	45.59	18.71
Accuracy in Narrative Text	99	93.31	8.15
Reading Speed in Narrative Text	99	92.09	20.45
Prosody in Narrative Text	99	9.40	3.24
Reading Comprehension Percentage in Narrative Text	99	48.55	22.74
Overall Accuracy Average	99	92.72	7.78
Overall Reading Speed Average	99	87.58	20.12
Overall Prosody Average	99	8.93	3.04
Overall Average of Reading Comprehension Percentage	99	47.07	17.88

Table 2 shows the findings of the Wilcoxon signed-rank test whether there is a significant difference between the students' percentages of the accuracy according to the text types.

Table 2. *Wilxocon Signed-Rank Test Results of the Accuracy According to the Text Types*

Informative-Narrative	*n*	Rank Mean	Sum of Ranks	*z*	*p*
Negative Ranks	41	42.60	1746.50	-2.543	.011*
Positive Ranks	58	55.23	3203.50		
Ties	0				
Total	99				

*$p < .05$

According to the findings of the Wilcoxon Signed-Rank Test, there was a significant difference between the percentages of words recognized by the students according to the type of the text (z= -2.543, p< .05). In fact, the difference scores are in favor of positive sequences show that students make less mistakes in narrative texts. According to the test results, the effect size of the text types on the accuracy (r= .18) was statistically small, (z= 2.543, p< .05.).

Table 3 shows the findings of the *t*-test for paired sample as to whether there is a significant difference between reading speeds according to the text types.

Table 3. *Paired-Samples t-test Results for the Reading Speeds According to the Text Types*

Groups	*n*	*M*	*s*	*SD*	*t*	*p*
Reading Speed in Informative Text	99	83.08	20.76	98	-10.155	.000
Reading Speed in Narrative Text	99	92.09	20.45			

*$p < .05$

Findings from the *t*-test for paired sample show that the reading speed of the narrative texts was significantly higher ($t_{(98)}$= -10.155, *p*< .05). The effect size of the test result (*d*= 1.02) shows that the difference is very large. Results reveal that the words in the informative language take longer to recognize while the students can recognize the words in the narrative text more quickly.

Table 4 presents the *t*-test results of the dependent groups on whether there is a significant difference between the prosody scores according to the text types.

Table 4. *Paired-Sample t-test for the Prosodies According to the Text Types*

Groups	n	*M*	*s*	*SD*	*t*	*p*
Prosody in Informative Text	99	8.46	2.97	98	-7.453	.000*
Prosody in Narrative Text	99	9.40	3.24			

**p< .05*

According to the results of the paired sample *t*-test, the narrative text was found to be read significantly more prosodicly by the students ($t_{(98)}$= -7.453, *p*< .05). The test result calculated the effect size (*d*= .75) shows that this difference is in the middle level. According to this findings, it is safe to say that students can read the narrative texts more appropriately in accordance with the prosody rules.

Table 5 presents the results of the *t*-test for paired sample as to whether there is a significant difference between the percentages of comprehension understood according to the text types.

Table 5. *Paired-Sample t-test Results for the Reading Comprehension Percentages According to the Text Types*

Groups	*n*	*M*	*s*	*SD*	*t*	*p*
Reading Comprehension Percentage in Informative Text	99	45.59	18.71	98	-1.378	.17
Reading Comprehension Percentage in Narrative Text	99	48.55	22.74			

According to the findings of the *t*-test of the paired sample,there was no significant difference found in the comprehension percentage according to the text type, ($t_{(98)}$= -1.378, *p*> .05).

Table 6 depicts the results of a simple linear regression analysis concerning the predictive validity of the informative text reading speed for the percentage mean of reading comprehension of informative and narrative texts.

Table 6. *Simple Linear Regression Analysis of the Prediction of Reading Speed in the Informative Text (R.S.I.T.) on Reading Comprehension Averages*

Variable	*B*	SE	*R*	R^2	Stand. β	*t*	*F*	*p*
R.S.I.T.	.390	.78	.453	.205	.453	5.006	25.057	.000*

n= 99 **p*< .05

As can be seen from the simple linear regression analysis concerning the predictive validity of the informative text reading speed for the percentage mean of reading comprehension of both informative and narrative texts, there was a significant relationship between the reading speed in the informative texts and the mean reading comprehension score (*R*= .453, R^2= .266). The reading speed was found to be a significant predictor of the mean of reading comprehension scores (*F*(1, 97)= 25.057, *p*< .05). The reading speed values obtained from informative texts explain 20% of the means of the reading comprehension scores. The significance test of the coefficient of the principal predictor variable to the regression equation (*B*= .390) shows that informative text reading speed is a significant predictor (*p*< .05). The regression equation that predicts the mean score of the reading according to the result of the regression analysis is as follows:

Reading comprehension score= (.390 x reading speed in the informative text) + 14.639.

Table 7 displays the results of the simple linear regression analysis of the predictive validity of the reading speed in the narrative texts for the reading comprehension percentage of both informative and narrative texts.

Table 7. *Simple Linear Regression Analysis of the Prediction of Reading Speed in the Narrative Text (R.S.N.T.) on the Reading Comprehension Averages*

Variable	*B*	SE	*R*	R^2	Stand. β	*t*	*F*	*p*
R.S.N.T.	.414	.78	.473	.224	.473	5.288	27.964	.000*

n= 99 **p*< .05

As a result of the simple linear regression analysis of the predictive validity of the reading speed in the narrative texts for the reading comprehension percentage of both informative and narrative texts, a significant correlation is found between reading speed in reading texts and mean reading comprehension score (*R*= .473, R^2= .224). It was seen that this reading speed was a significant predictor of the mean of the reading comprehension scores (*F*(1, 97)= 27.964, *p*< .05). The reading speed obtained from the narrative texts explains 22% of the reading comprehension mean scores. The significance test of the coefficient of the principal predictor variable to the regression equation (*B*= .414) shows that the reading speed of the narrative text is a significant predictor (*p*< .05). The regression equation that predicts the reading comprehension mean score according to the regression results is as follows:

Reading comprehension score = (.414 x reading speed in narrative text) + 8.965.

Table 8 demonstrates the simple regression analysis results concerning the predictive validity of the reading speed for the mean values of reading comprehension percentage means in both informative and narrative texts.

Table 8. *Simple Linear Regression Analysis of the Prediction of the Reading Speed Averages (R.S.A.) on the Reading Comprehension Averages*

Variable	*B*	SE	*R*	R^2	Stand. β	*t*	*F*	*p*
R.S.A.	.421	.79	.474	.225	.474	5.301	28.106	.000*

n= 99 **p*< .05

The simple regression analysis results concerning the predictive validity of the reading speed for the mean values of reading comprehension percentage means in both informative and narrative texts show that, a significant relationship was observed between the reading speed average and the reading mean point readings (*R*= .474, R^2= .225). The findings reveal that reading speed was a significant predictor of the mean of the reading comprehension scores (*F*(1, 97) = 28.106, *p*< .05). The reading speed means explains 22% of the reading comprehension mean scores. The significance test of the coefficient of the principal predictor variable to the regression equation (*B*= .421) shows that the mean reading speed is a significant predictor (*p*< .05). According to the result of the regression analysis, the regression equation that predicts the reading comprehension mean scores is as follows:

The reading comprehension score = (.421 x reading speed average) + 10.177.

Table 9 exhibits the results of a simple linear regression analysis of the predictive validity of the prosodic reading scores in the informative texts for the reading comprehension percentage mean scores in both informative and narrative texts.

Table 9. *Simple Linear Regression Analysis of the Prediction of Prosody in the Informative Text (P.I.T.) on the Reading Comprehension Averages*

Variable	*B*	SE	*R*	R^2	Stand. β	*t*	*F*	*p*
P.I.T.	2.799	.54	.465	.217	.465	5.179	26.824	.000*

n= 99 **p*< .05

As a result of the simple linear regression analysis of the predictive validity of the prosodic reading scores obtained from the informative texts for the reading comprehension percentage mean scores obtained from both the informative and narrative texts, it was concluded that there is a significant relationship between the prosody scores in the informative texts and the reading comprehension mean scores (R= .465, R^2= .217). These prosodic scores were found to be a significant predictor of the reading comprehension mean scores (F(1, 97)= 26.824, p< .05).

The prosody scores obtained from the informative texts explains 21% of the reading comprehension mean scores. The significance test of the coefficient of the principal predictor variable to the regression equation (B= 2.799) shows that the prosody score in the informative texts is a significant predictor (p< .05). The regression equation that predicts the reading comprehension mean score according to the result of the regression analysis is as follows:

Reading comprehension score= (2.799 x prosody score from informative text) + 23.369.

Table 10 shows the results of a simple linear regression analysis of the predictive validity of the prosody scores in the narrative texts for the reading comprehension percentage means in narrative and informative texts.

Table 10. *Simple Linear Regression Analysis of the Prediction of Prosody in the Narrative Text (P.N.T.) on the Reading Comprehension Averages*

Variable	*B*	SE	*R*	R^2	Stand. β	*t*	*F*	*p*
P.N.T.	2.364	.505	.429	.184	.429	4.677	21.875	.000*

n= 99 **p*< .05

The results of the simple linear regression analysis of the predictive validity of the prosodic reading scores obtained from the narrative texts for the reading comprehension percentage mean scores obtained from both the informative and narrative texts, reveal that there is a significant relationship between the prosody scores in the informative texts and the reading comprehension mean scores (R= .429, R^2= .184). These prosodic scores were found to be a significant predictor of the reading comprehension mean scores (F(1, 97) = 21.875, p< .05). The prosody scores obtained from narrative texts explains 18% of the reading comprehension mean scores. The significance test of the coefficient of the principal predictor variable to the regression equation (B= 2.364) shows that the prosody scores in the narrative texts are significant predictors (p< .05). The regression equation that predicts the reading comprehension mean score according to the result of the regression analysis is as follows:

Reading comprehension score= (2.364 x prosody score from the narrative text) + 24.830.

The results of the simple linear regression analysis of the predictive validity of the prosodic reading scores means for the reading comprehension percentage mean scores in the informative and narrative texts are presented in Table 11 below.

Table 11. *Simple Linear Regression Analysis of the Prediction of the Prosody Averages (P.A.) on the Reading Comprehension Averages*

Variable	*B*	SE	*R*	R^2	Stand. β	*t*	*F*	*p*
P.A.	2.671	.53	.455	.207	.455	5.037	25.369	.000*

The result of the simple linear regression analysis of the predictive validity of the prosodic reading scores obtained from both types of texts for the reading comprehension percentage mean scores obtained from both informative and narrative texts revealed that there is a significant relationship between the prosody scores in the informative texts and the reading comprehension mean scores (R= .455, R^2=.207). These prosodic scores were found to be a significant predictor of the reading comprehension mean scores (F(1, 97) = 25.369, p<.05). The prosody scores obtained from the narrative texts explains 20% of the reading comprehension mean scores. The significance test of the coefficient of the principal predictor variable to the regression equation (B= 2.671) shows that the prosody scores in the narrative texts are significant predictors (p< .05). The regression equation that predicts the reading comprehension mean score according to the result of the regression analysis is as follows:

Reading comprehension score= (2.671 x prosody score) + 23.198

The relationship between the reading fluency and the reading comprehension scores according to the text types and average points obtained from those text types is presented in Table 12 below.

As Table 12 illustrates, the reading fluency values and the reading comprehension scores obtained from both informative and narrative texts have a significant and positive relationship with both values in itself and other values. The lowest correlation values in informative and narrative scores were found between accurasies (word recognition percentages) and reading comprehension percentages (r= .308, p< .05; r= .402, p< .05). The highest correlation values in informative and narrative scores were found between the prosodies and the reading speeds (r= .827, p< .05; r= .796, p< .05). The lowest correlation value between informative and narrative text scores was found between reading comprehension percentage in the informative text and the accuracy in the narrative text, (r= .257); and the highest was between prosodies (r= .922).

Conclusion and Discussion

The reading fluency skill has been the subject of various research in different contexts. Findings of the reading fluency and the reading comprehension of the study will be discussed in the following pages under five different titles.

Discussion of the Findings on the Differentiation of the Reading Fluency and the Reading Comprehension depending on the Text Type

Findings of this research in relation to the above heading are quite striking. Findings showed that all elements of the reading fluency varied significantly according to the text, while reading comprehension show no important variation.

Table 12. *Correlations Between the Reading Fluency and the Reading Comprehension According to the Text Types and Averages*

		Informative Text				Narrative Text				Averages			
	R. F. C.*	Speed	Prosody	Accuracy	R.C.P.**	Speed	Prosody	Accuracy	R.C.P.**	Speed	Prosody	Acuracy	R.C.P.**
Informative Text	Speed	1											
	Prosody	.827***	1										
	Accuracy	.738***	.713***	1									
	R.C.P**	.376***	.342***	.308***	1								
Narrative Text	Speed	.908***	.767***	.603***	.357***	1							
	Prosody	.820***	.922***	.691***	.303***	.796***	1						
	Accuracy	.575***	.638***	.705***	.257***	.566***	.708***	1					
	R.C.P.**	.403***	.450***	.390***	.484***	.450***	.426***	.402***	1				
Averages	Speed	.977***	.816***	.680***	.375***	.976***	.827***	.587***	.437***	1			
	Prosody	.840***	.979***	.708***	.328***	.798***	.982***	.681***	.446***	.838***	1		
	Accuracy	.723***	.732***	.946***	.302***	.626***	.749***	.878***	.401***	.689***	.747***	1	
	R.C.P.**	.453***	.465***	.409***	.831***	.473***	.429***	.393***	.889***	.474***	.455***	.412***	1

**R.F.C.= Reading Fluency Components* ***R.C.P.= Reading Comprehension Percentage* ****p< .01*

When the accuracy of the reading informative and narrative texts (percentage of the word recognition) was examined, it was understood that the students read the narrative texts more accurately. Hence, it is accurate to say that students who are more familiar with the words in the narrative text made less frequent reading mistakes. In informative texts, more reading mistakes were observed, though the difference in the effect sizes of the difference between the text types is statistically small (*r*= .18), indicating that the difference is not of great importance.

When the reading speed in the informative and narrative texts is examined, it is seen that the students read the narrative texts significantly faster and the effect size is very large (*d*= 1.02). According to the theory of automaticity; the better the readers are capable of resolving the words, the faster they are capable of read. When these results are evaluated in this context, it can be concluded that the words in the narrative texts are more familiar to the students. It can be said that, due to the words in the informative text being relatively different, the subject matter is more information-intensive and the structure of the informative text is more complicated compared to the narrative texts, the reading speed decreases.

It can also be said that students are more successful in terms of reading prosody when they vocalise narrative texts. Findings depict that there is a significant difference between the prosody scores according to the text types and this difference is statistically moderate (*d*= .75). These conclusions can be interpreted as students are able to reflect addressing, excitement, fear etc.-which are embedded in the nature of narrative texts in their speeches and are better at emphasis-toning-expression. Given that the informative texts have fewer emotional transitions, dialogues, and exclamations (e,g. surprise and sadness), it can be drawn a conclusion here that such a result is natural. One of the most surprising results of the study is that no significant difference between the reading comprehension percentages in different text types was found. In particular, the relationship between the prosody-reading comprehension in the previous studies (eg. Baştuğ & Akyol, 2012; Calet, Gutiérrez-Palma, & Defior, 2015; Çetinkaya, Yıldırım, & Ateş, 2017; Yamaç & Çeliktürk Sezgin, 2018) (especially the significant difference of the prosody) and the findings in this study of the significant differentiation of the reading fluency elements according to the text type evoke the idea that reading comprehension percentages would also differentiate based on the type of the text. However, the results did not meet this expectation.

In the research conducted by Diakidoy, Stylianou, Karefillidou, and Papageorgiou (2005), it was seen that in all second, fourth, sixth, and eighth graders mostly understood narrative texts better when they read and listened to. Yıldırım et. al. (2010) stated that students understood the narrative texts better than the informative texts. On the contrary, Güneyli (2008) found that students studying in an elementary school education department at a university understood the informative texts better than the narrative texts.

Findings of the previous studies and findings of this research show no consistency in terms of students' understanding level of the narrative texts. Research generally shows that narrative texts are understood more, but there are studies showing otherwise. In addition, this study has been added to previous findings that there is no difference in the occasion. Findings of this studyreveal no significant difference between the percentages of the students' reading comprehension based on the two different text types. From all these results, it can be understood that it is necessary to be cautious when approaching to the idea that any type of text is easier to understand. According to the popular belief which suggests that students, who are exposed to the narrative texts, can easily understand them and the explanations for this are attributed to many reasons such as familiarity of the text and technical terms within the text. Findings of this study, however, have not confirmed this popular belief.

The Relationship between the Elements of the Reading Fluency Obtained from the Same Text

According to the findings of the study, the reading fluency values obtained from the informative text have a positive significant relationship between themselves. A positive correlation was also found between the reading fluency values obtained from the narrative text. The highest correlation between the values obtained from the informative text was found between the reading speed and the prosody (*r*= .827). Followed by the relationship between the reading speed and the word recognition percentage (*r*= .738) and the word recognition percentage and the prosody (*r*= .713). The highest correlations in the narrative text are ordered as reading speed-prosody (*r*= .796), word recognition percentage-prosody (*r*= .708) and word recognition percentage-reading speed (*r*= .566). The order of the magnitude of correlations between reading fluency elements has changed according to the text.

The findings of the reading fluency skills show a significant positive relationship with each other, though they contradict some of the findings of other researchers while showing similarities with some of the other's findings. Bastug and Akyol (2012) have found that there is a moderate relationship between the components of the reading fluency at the lowest level. The lowest correlations were found between the prosody and the correct reading, with the highest correlation being between the prosody and the reading rate (*r*= .869). Yamac and Celikturk Sezgin (2018) also found significant relationships between the reading fluency elements. According to this, between the reading accuracy percentage and prosody there is a .50 relationship; and between reading accuracy percentage and reading speed there is a .40 significant relationship. Calet et al. (2015) found significant positive correlations between the prosodic reading and the reading speeds in the second and fourth grades.

Findings of Basaran (2013) showed no matching with the findings of this study. Başaran (2013) depicted a significant relation of .226 between the reading speed and the prosody. In this study, the number of incorrect readings was taken under consideration instead of the reading accuracy percentage. A correlation of -.17 was seen between incorrect reading amount and the speed; while a correlation of -.65 is seen between the number of the incorrect readings and the prosody. Despite the expectation of a negative relationship between the prosody and the incorrect reading, the correlation turned out to be meaningless does not fit in with the findings of our study and other studies.

When the findings of this study are discussed with the findings of the previous studies, it can be said that the reading fluency elements have a significant positive relationship with each other, though there is an existence of some contradictions. However, the answer to the question of "Which elements have the highest correlation?" remains unclear. Different orders arise in different studies. However, it appears that the prosodic skill is particularly strong in relation to the other two skills. In other words, there is no serious relationship found between the reading speed and the accuracy, but the correlation of the prosodic skill with these two factors is a fact to be taken into consideration. Whatever the type of the text, the reading fluency elements from the same text type seem to have strong connections with each other. However, there remains a need to look at the relationships between reading fluency values obtained from texts with different characteristics.

The Relationship between the Elements of the Reading fluency Obtained from the Different Texts

Findings of the study were obtained from two different texts, namely narrative and informative texts. A significant positive correlation was found between reading fluency elements according to the text types.

Among the correlations of the reading fluency values between texts, the highest values were found between the prosodies (*r*= .922), between the reading speeds (*r*= .908) and between the reading speed in informative texts and the prosody in the narrative texts (*r*= .820). The lowest correlation values were found between the reading speed in the informative texts and the word recognition percentage in the narrative texts (*r*= .575), between the word recognition percentage in the informative texts and the reading speed in the narrative texts (*r*= .603) and between the prosody in the informative texts and the word recognition percentage in the narrative texts (*r*= .638).

According to the findings of the study, it can be said that the reading fluency skills are better reflected in accordance with each other even though if the text types differ. In other words, a student who is capable of reading a narrative text well is expected to read an informative text well, too. Contrary to the general acceptance of the idea that informative texts are more challenging, findings of this study showed that students who are capable of reading a narrative text well are also successful in reading informative texts in their respective grades.

Relations between the Reading Comprehension and the Reading fluency Elements Based on the Type of the Text

Research findings revealed that, the meaning and direction of the relationships between the reading comprehension and the reading fluency skills do not change according to the text. When the reading comprehension values which were obtained from the informative text compared with the averages of the reading fluency values the reading speed (*r*= .375) was found as the highest correlation. This is followed by the prosody (*r*=.328) and the accuracy (*r*= .302). It is noteworthy to note that the reading comprehension rate mean in narrative texts and the reading fluency values obtain higher rates and the prosody has the highest correlation. There is a significant positive correlation (*r*= .446) between the reading comprehension in narrative texts and the mean prosodic value. This is followed by the reading speed (*r*= .437) and the accuracy (*r*= .401). According to these findings, the importance of the speed in the informative texts emerges. Prosodic elements (transfer of emotions, pauses, and sounds) have a very important role in the informative texts, however, the importance of this role has been reduced compared with the narrative text. This probably indicates the necessity of understanding the characters' feelings of the narrative text. For the reason of the informative text having being information rather than emotion, prosody may have been degraded to the second rank. Hence, it can be said that different reading fluency elements should be emphasized in different text types.

The findings of the study are consistent with some of the findings of other research while those findings contradict with other findings. For example, Klauda and Guthrie (2008) investigated the reciprocal relationship between the reading fluency and the reading comprehension in the fifth grade students over a 12-week period. They found that the reading fluency predicted growth in reading comprehension across time points. Additionally, they found that comprehension, as measured at the beginning of their research, predicted the growth in reading fluency after the 12-week time period. Another study by Yıldız et al. (2014) showed that the automaticity, accuracy, and prosody were significantly correlated with the reading comprehension of the fifth grade students.

Çetinkaya et al. (2017) found that there was a significant relationship between the reading prosody and the reading comprehension (simple and inferential based) of

.42. Bastug and Keskin (2012) found a significant positive relationship between the reading fluency and simple and inferential comprehension. However, the relationship of the reading fluency skills for inferential comprehension is found to be stronger than that of simple comprehension. According to Bastug and Akyol (2012), the one occurs with the lowest relation between the reading fluency elements and the reading comprehension is between the reading comprehension and the reading accuracy (*r*= .552). This was followed by the reading speed (*r*= .707) and the prosody (*r*= .852), respectively. Yamac and Sezgin (2018) found significant relationships between the reading comprehension and the prosody of .51; between the reading comprehension and the reading speed of .43; between reading comprehension and word recognition percentage of .40. According to Aytac (2017), there are moderately significant correlations between the prosodic skills of the second and third graders and the meanings they read. Similarly, Rasinski, Rikli, and Johnston (2009) found a significant relationship between the reading out loud prosody of the third, fifth, and seventh grade students and their silent readings.

Calet et al. (2015) found significant positive relationships between reading comprehension in grade two and four and reading speed and prosodic reading. They also looked at the relationships between the elements of prosodic reading (sound, tonality, pauses, compartments of meaning units, and quality) and reading comprehension. The elements with the highest correlation with comprehension were division of meaning units (.55), quality and pauses (.55), intonation (.52), and voicing (.36). This ranking has changed at the fourth grade level and the rates have declined. According to the ranking in the fourth grade the relationships were found as follows: intonation (.42), quality (.40), division into meaning units (.37), pause (.29), and voicing (.14). In the fourth grade, voice is the only element that has shown no significant relationship.

Basaran (2013) summed up the reading comprehension skill with four different data tools: gap filling, multiple choice, in-depth understanding, and short answer. The relationship between these tests and prosody was found to be insignificant regarding multiple choice and short answer tests while having a significant correlation of .249 and 0.847 with gap-filling and in-depth questions, respectfully. Hence, there has not been found a link between prosody and the mechanic structure of reading nor a link found between remembrance of specific details. It is found that the reading speed has a significant correlation with in-depth measuring instrument (*r*= .398) only. This means that there is a limited relationship between the reading out loud speed and the reading comprehension, which suggests that the reading speed may not contribute to the comprehension after a certain level has been reached. When it is looked at the relationship between the number of mistakes made and comprehension, the highest significant associations can be found between multiple choice (*r*= -.791), gap filling (*r*= -.555), and short answer (*r*= -.529). There was no meaningful relationship with questions that require deep meaning. This may suggest that, the increase in the number of mistakes reduces superficial meaning and remembrance.

Kaya and Yıldırım (2016) found a significant relationship between the reading fluency and the inferential comprehension regarding the narrative text. There is no relationship between the reading fluency and simple comprehension obtained from the narrative text in the study. In the same study, findings showed that there are significant relationships between the reading fluency and simple-inferential meanings which were obtained from the informative text type. In this study, only the speed and prosody dimensions of the reading fluency were discussed. Çetinkaya, Ulper, and Yagmur (2015) looked at the relationship between the silent reading of the reading cards in an accurate and fluent manner and the reading comprehension. In this study, significant correlations were found between the first and second classes reading comprehension and the silent reading fluency, while no significant relationship was found in the fourth grade.

Another finding of the study shows that, the percentage of the comprehension in the two types of the text has a positive relationship with each other (*r*= .484). This finding shows a similarity with the findings of Yıldırım, Yıldız, and Ates (2011). Yıldırım et al. (2011) found a significant relationship between comprehension of narrative texts and comprehension of informative texts in the fourth grade. Therefore, it can be said that there is a moderate relationship between the students' ability to understand both the informative and narrative texts.

Predictive Validity of the Reading fluency for the Reading Comprehension

The study has examined the reading speed and prosody scores obtained from two different types of the texts. In addition to that, the study has looked into the effect and prediction of mean scores on the reading comprehension scores in the two different texts. . The predictive validity of the word recognition percentage for reading comprehension was not examined since the normal distribution requirement for a simple linear regression was not met.

Findings showed that, the reading speeds results on both types of the texts, the mean of these speeds, the prosody scores of both texts, and the mean of these scores significantly predicted the reading comprehension means.

The reading speed values obtained from the informative texts explain 20% of the mean reading comprehension scores; the reading speed obtained from the narrative texts explain 22% of the mean reading comprehension scores while the mean of the reading speeds of both texts explains 22% of the mean reading comprehension scores.

The prosody score obtained from the informative texts explains 21% of the mean reading comprehension scores; the prosody score obtained from the narrative texts explains 18% of the mean reading comprehension scores while the mean of the prosody scores of both texts explains 20% of the mean reading comprehension scores.

When previous works are examined, it is understood that there is no consistency regarding the predictive validity of reading fluency elements for reading comprehension. Some studies do not support the findings of this study while others do. However, in general, it can be said that the prosodic skill is an important predictor of the reading comprehension.

Çetinkaya et al. (2016) reported that the speed of word recognition in the study they did at high school revealed a significant direct effect on reading comprehension and that it explains a 25% variance. The speed of word recognition has a direct effect on the prosody and it reveals a variance of 29%. Following these analyzes, the prosody has been added as an intermediary variable between the speed of word recognition and reading comprehension. In this case, it has been suggested that the direct effect of word recognition speed on reading comprehension is no longer significant, while the indirect effect of it has increased.

Aytac (2017) has suggested that prosody significantly predicts reading comprehension in the second, third, and fourth grades. Furthermore, Calet et al. (2015) claimed that prosodic reading explains %5 percent of reading comprehension in the second grades while it explains 10% of reading comprehension in the fourth grades. According to the structural equivalence model of Yamac and Celikturk Sezgin (2018), the reading fluency directly and indirectly predicts reading comprehension (β= .45).

Bastug and Akyol (2012) have discovered that the reading fluency skills can predict reading comprehension on a significant scale. Three variables have been found suggesting to have a prediction level of %72 when used cooperatively. Prosody was found as the highest predictive validity. The reading speed and the reading accuracy were found not to be a significant predictor for the reading comprehension.

Lai, George Benjamin, Schwanenflugel, and Kuhn (2014) examined the longitudinal relationship between reading fluency and reading comprehension by modeling the interaction between the two over time. This model claims that comprehension skills can impact reading fluency and this impact is far greater than the impact that reading fluency has on comprehension skills. The findings of this research show that, compared to the traditional model in which reading fluency predicts concurrent comprehension, models showing a reciprocal relationship do not represent the data better.

In the study of Kaya and Yıldırım (2016), the reading fluency values obtained from the narrative text type explained the 11% variance of the inferential meaning, but in simple terms this ratio decreased to .02%. The same rates are 22% to .09% for informative texts. In this study, the speed and prosody dimensions of the reading fluency were only discussed.

When Basaran (2013) examined the predictive validity of the reading fluency skills for four types of reading comprehension tests, he discovered that the reading fluency (speed, accuracy, and prosody) predicts 76% of in-depth comprehension, %64 of multiple-choice, %26 of short answer tests, and %35 of the gap filling results. The relative importance of the reading fluency skills varies in these metrics. The most important reading fluency skills in in-depth comprehension are prosody, accuracy, and speed. In a multiple-choice test, the ranking is accuracy, speed, and prosody. In short response test and gap filling, accuracy, prosody, and speed are listed. These results can be interpreted as the ability of the reading fluency skills to predict an achievement of in-depth reading comprehension. Prosody is at the forefront in this procedure. In addition to this, reading accuracy is more influential than speed for reading comprehension. In short answer tests, the reading speed has a meaningless but there is a negative relationship with the reading.

When the studies on the predictive validity of the reading fluency for the reading comprehension are examined, it is understood that the reading fluency overall succeeds to predict the reading comprehension. In particular, the extent prosodic reading explains the variance in reading comprehension is remarkable. These results can be interpreted as the effect of students' ability to divide the texts into meaning units, transmit emotions and pay attention to pauses on reading comprehension to be substantial. However, when it is evaluated with the other research findings, it appears that the effect of the reading speed on understanding is controversial. Findings of this along with findings of some other studies show that the reading speed can be accepted as a predictor for the reading comprehension. However, it is not always the case as other research suggests otherwise.. Therefore, it can be said that the effectiveness of the reading speed is over the reading comprehension needs more scholarly attention.

Suggestions

This study revealed that the reading fluency skills differ significantly according to the text. Therefore, in order for the researcher to evaluate students' reading fluency skills appropriately, it may be helpful to utilize both types of the texts in their examination. Finding a significant difference in the ability of reading according to the text is limited to the findings of this study and it is, therefore, necessary to employ both types of texts for deciding the level of the comprehension. In the same way, it would be more realistic to reach a decision by taking the average of both types of texts in the determination of both of the level of the reading comprehension and the level of the reading fluency skills. Hence, various text types such as poems, memoirs, and biographies can be useful for measuring and evaluating reading fluency skills.

It has been examined in the findings of the study that, reading fluency elements (reading speed, and prosody) can predict reading comprehension skills significantly. Considering the findings of the study and other researches made in the field, it can be concluded that identification of the reading skills and effort made for the improvement of these skills will contribute to the ability. Early detection of some problems in the classroom environment may become possible through the identification of the reading fluency levels of students. Teachers can benefit from reading fluency levels for anticipating their level of comprehension. Relevant regression equations are given in the findings section of the study. Such regression studies may need more generalization in different systems. However, in very crowded classrooms, if time and opportunities are limited, it is possible to detect students' both reading fluency skills and comprehension skills - of course with a certain margin of error - by taking only one-minute reading. Furthermore, this will make it easier for teachers who do not have the necessary conditions.

Study Limitations and Directions for Future Studies

This research is limited to 99 students aged between 10 and 11 studying at the fifth grade of a secondary school affiliated with the Turkish Ministry of National Education. Future research may benefit more by examining students of different age groups. In this study, while analysing the relationships between the reading fluency components and the reading comprehension, the text type was considered as a variable and the narrative text and informative text were evaluated separately but the difficulty level of the texts was not examined as a variable. We suggest that future studies can take these variables, including poems, into their considerations. At the same time, the relationship between the students' oral reading skills and silent reading comprehension was investigated. In the future research, once the relationship between the reading fluency and the oral reading comprehension is established, comparisons can be made between these two variables and findings can be discussed comparatively.

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Philosophy for Children in Teacher Education: Effects, Difficulties, and Recommendations

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Abstract

It is necessary to realize widespread and effective implementation of philosophy for children (P4C) in teacher education. Learning the views of teacher candidates and identifying implementation-related difficulties can help determine the content of such education. Thus, thirty teacher candidates who participated in an elective P4C course were studied. Data obtained through a qualitative study showed that the candidates struggled to ask questions, conduct debates, and associate philosophy with curricula. However, their perceptions of childhood and philosophy changed positively. In order for P4C teacher education to succeed, the importance of philosophical knowledge and perspectives should be emphasized, discussion and questioning processes should be analyzed, and candidates should receive feedback and have opportunities for practice and self-assessment.

Keywords: Philosophy For Children, Teacher Training, Teacher Candidates

Introduction

Matthew Lipman initiated philosophy for children (P4C) in the 1970s. Pre-school to high school aged children from many countries were taught philosophy, and had the opportunity to philosophize with their classmates. Thus, P4C research also began. In studies, P4C's relationship with thinking skills (Daniel & Auriac, 2011; Millett & Tapper, 2012), democracy (Bleazby, 2006; Burgh & Yorshansky, 2011), citizenship (Garrat & Piper, 2011; Splitter, 2011) and values education (Cam, 2014) has come to the forefront. In addition to P4C's contributions to children's reasoning skills (Lam, 2012; Marashi, 2009), studies have also noted its impact on children's ability to debate (Cassidy & Christie, 2013; Poulton, 2014). Despite fifty years of such contributions, P4C has been institutionalized in only certain countries, and continues to exist only through concerted efforts of educators; it is not well-recognized globally. In addition to the challenges faced by the promotion of non-traditional approaches in schools, P4C also has its own unique problems. These problems impede an extensive and effective implementation.

Philosophy Education and Philosophy Perception

P4C's main obstacle is traditional philosophy education—the transfer of philosophical knowledge rather than philosophizing (UNESCO, 2009). Schools' traditional philosophy education negatively affects philosophical perceptions. Philosophy is seen as a mass of complicated and confusing information reflecting only the views of philosophers; its relationship with thinking processes and its value in human life are ignored. Popper (2006) says that everybody is capable of philosophy: we can each accept many concepts. Such non-critical assumptions are often philosophical. Sometimes they are true, but often they are fallacies. Whether we think rightly or wrongly can only be identified through a critical examination of the philosophies that we accept. This critical examination is the source and responsibility of philosophy. Popper says that philosophy applies to everybody, especially when approached appropriately. Philosophy education should bridge the relationship between philosophy and our lives, and teach us to think rightly. Kuçuradi (2006) states that the Paris Philosophy Declaration of the United Nations Educational, Scientific and Cultural Organization (UNESCO)'s philosophy education encourages thinking, openness, responsible citizenship, understanding, and tolerance. He also asserts that it generates responsibility for ethical problems, especially significant contemporary problems, by promoting independence in thought, and enabling people to question diverse forms of propaganda. In order for these achievements to occur, philosophy education should not merely transfer the history of philosophy, it should also include philosophizing. Kant says that philosophizing, not philosophy, is to be learned (Comte-Sponville, 2006). Philosophy occurs when we ask questions, debate and test thoughts, consider possible evidence against ourselves, and question our concepts (Nagel, 2004). Philosophizing makes it possible to actualize philosophy's critical attitude as well as relate it to human life. Philosophy education should be reassessed through this point of view; otherwise, a philosophy education appropriate for its purpose and aligned with the nature of philosophy will not be realized.

Childhood Perception

Lyle (2014) notes that teachers' perceptions of childhood influence the quality of P4C practices. Hand (2008) explains the misconception that children cannot grasp philosophy, both by exaggerating the cognitive capacity required for philosophy and by underestimating the cognitive capacities of children. Philosophers are often perceived as unattainable intellectuals, disconnected from the practicalities of daily life, giving incomprehensible answers to unsolvable questions (Billington, 2011). As mentioned above, this view is justified by the inadequate quality of current philosophy education, wherein some teachers are not concerned with whether philosophy is understood, and/or believe that its understanding requires special talents. However, the history of philosophy has likened children and philosophers. Montaigne (2006) states that it is a mistake to represent philosophy to children

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as something unattainable, frowned upon, and troublesome. Jaspers (2010) states that it is common for children to ask questions, thereby encouraging people to philosophize. The childlike ability to wonder and marvel is at the heart of philosophy. Children, like philosophers, perceive the world and everything on it as new, thus everything provokes their curiosity and astonishment (Cevizci, 2010). Children's courage is also necessary to philosophize—a thinker requires the courage to see and express problems, as they are, against all prejudices of his own era and position (Hösle, 2004).

The underestimation of children's cognitive capacities consists of philosophical, cultural, and psychological factors that are related to and sustain one another. According to Matthews (2000), the concept of childhood is problematic culturally, historically, and philosophically. Children are profound and surprising: this combination also describes the classical field of philosophy, but one finds no mention of children in 2,500 years of written philosophy. This has only recently begun changing: philosophers now recognize the importance of babies and are learning new things from them. Indeed, philosophical encyclopedias now feature titles such as 'Baby Mind Theory' and 'Baby Perception' (Gopnik, 2012).

Matthews (2000) argues that children's philosophical thinking capacities are not represented in the concept of childhood that developmental psychologists offer. Dismissing children's philosophical thinking capacity encourages the underestimation of childhood. Here, Matthews points to Piaget's theory of development, asserting that children cannot perform certain mental processes before a certain age, and that children's thinking skills are limited by their maturity. Vygotsky (1998) criticizes Piaget's views on the grounds that he ignores children's experiences. According to Vygotsky, Piaget does not consider socio-cultural factors and school coursework, both of which influence children's thinking. Instruction plays an important role in the development of children, opening up human-specific qualities of the mind and taking children to new levels of development.

According to Piaget, children lack original moral knowledge because they must be taught to empathize or sympathize, and cannot understand intentions and abstract rules; modern science discredits this view (Gopnik, 2012). Experimental studies with five-year-old children have shown that children can identify with others and comprehend what other children think: they can understand and manipulate thoughts that differ from their own and to which they object, and they can accomplish abstract thought processes and reason about abstract philosophical concepts (McCall, 2009).

As Matthews notes, the concept of childhood is also historically problematic. Wall (2010) has explained three models of historical perceptions of childhood. The first model sees childhood as a natural state of moral disorder, describes children as rebellious, asserting that they should be disciplined. The second model assumes that a child is innately worthy, and should be guided to preserve their pure, incorrupt state, with necessary support to resist corruption. The third model describes children as 'developing'. Children are potential adults, and childhood is considered to be independent from other periods of life. The roots of this model, which is applicable to modern childhood, extend to Locke and even Aristotle. Murris (2016) has also mentioned the 'fragile child' model that emerged in the 20th century. This model, inspired by the psycho-medical scientific theory, describes children by deriving concepts such as 'talented' and 'hyperactive', and focuses on protecting, diagnosing, and improving children.

Children have been both embraced and controlled by adults throughout history (Holt, 1995). These models, which have evolved into one another and disseminated their effects in every century, have affected children's education. These models ignore children's individual differences, disregard their capacity for independent thinking and decision-making, and lead adults to perceive them as requiring direction. Wall (2010) has defined children as creative individuals, rather than classifying them as 'good', 'bad', or 'neutral'. Murris (2016) posited a post-humanist understanding of childhood, rather than conceptually labeling the child's nature with 'innate/cultural' dualities. In order to be able to philosophize with children, it is necessary to eliminate adult perspectives that disdain children's capabilities.

Personal Epistemology

Epistemology is a field of philosophy dealing with the nature of human knowledge. Personal epistemology and epistemological beliefs reveal how individuals know, their theories and beliefs about knowing, and the influence of their epistemological frameworks on their thought and reasoning processes (Hoffer & Pintrich, 1997). Schommer (1990) classified personal epistemology into five dimensions: the source of knowledge, the precision of knowledge, the organization of knowledge, the control of learning, and the speed of learning. The views on the source of knowledge are distributed between the transfer of knowledge from authorities who know everything, and the generation of knowledge attained by individuals themselves. The belief that knowledge is precise and absolute is confronted by the belief that it constantly changes. The belief that knowledge is organized in patterns is opposed by the belief that knowledge has a complex structure. The thought that the ability to learn is innate differs from the thought that it is gained through experience. The thought that learning occurs quickly (or not at all) is confronted by the belief that it is a gradual process. Research shows that teachers' personal epistemologies affect learning processes and teaching practices (Brownlee, 2004; Olafson & Schraw, 2010). It has been observed that teachers who believe that learning is a process and students are capable of understanding the world and developing their own views more effectively use more diverse learning strategies than teachers who believe that external support is necessary for learning and that students cannot form their own ideas. In addition, teachers with constructivist and flexible epistemological beliefs accept the existence of alternative thoughts rather than finding the answers of students 'correct' or 'unacceptable' (Hashewh, 1996). An approach in which knowledge is absolute and alternative views are unacceptable disrupts inquiry-based activities in the classroom and the process of philosophizing with children. Knight and Collins (2014) observed that despite a dedicated effort, P4C could not substantially progress in Australia, partly due to the teachers' epistemological beliefs.

When the effects of teacher candidates' personal epistemologies on their teaching practices are taken into account, it is clear that the relative nature of education and influence of candidates' views must be addressed. It is important to offer candidates more complex and relative epistemologies—rather than personal epistemologies in which knowledge is perceived as absolute and simple—and to involve them in more reform-based instructional practices (Yadav, Herron, & Samarapungavan, 2011). It is evident that methods such as P4C cannot survive unless there are democratic and collaborative approaches in teacher education. In fact, teachers generally are not ready to use a teaching strategy that is not knowledge- based. Therefore, P4C education must occur in pre-service and in-service teacher education (N. R. Lane & Lane, 1986).

Philosophical Background

Another obstacle to realizing P4C's goals is the belief that a philosophical background is not required in order to teach philosophy to children. What is meant here is not rote knowledge of the history of philosophy or the views of philosophers. According to Wartenberg (2009), to philosophize, we need to know and ask philosophical questions, to be aware of the subjects of philosophy, and to be able to give examples of abstract subjects of discussion. However, awareness of the basic elements of conducting a philosophical debate is critical. It is also necessary to distinguish qualified answers to philosophical questions. Introducing children to an anti-intellectual education that claims that each idea is of the same value can harm philosophy. In terms of increasing teachers' abilities to philosophize, the inclusion of philosophical knowledge in P4C teacher education is important (UNESCO, 2007). Worley (2009) states that P4C facilitators should have basic, not expert, philosophical knowledge. Just as someone unfamiliar with history or math cannot teach these courses, someone unfamiliar with philosophy cannot teach philosophy. It is necessary to know the value and meaning of philosophy and understand that it is not a method without content. Otherwise, as Vansieleghem (2005) points out, P4C will be instrumentalized, and lose its authenticity.

The obstacles to P4C's effective widespread adoption and implementation include negative perceptions of philosophy and philosophy educators' fostering those perceptions, opinions regarding childhood, teachers' personal epistemologies, and their lack of any philosophical background. The purpose of this study is to propose an organization of P4C education content in response to the problems identified above. Accordingly, this study was carried out among elementary education and psychological counseling and guidance teacher candidates who were enrolled in the P4C elective course in a Turkish university. The questions for the study were:

1. What is the impact of the P4C course on teacher candidates'

    a. perceptions of philosophy; and

    b. perceptions of childhood?

2. What are the difficulties faced by teacher candidates in planning and executing P4C activities?

3. What are the views of teacher candidates regarding the involvement of P4C in the process of teacher education?

Method

In this study, a qualitative research method was employed to understand the feelings and thoughts, together with the underlying rationale, of the teachers who participated in P4C, and to obtain information about the P4C course in teacher education. The course lecturer, whose field of study was P4C, was also the researcher. The data were gathered by the researcher using qualitative data collection instruments by observing the participants in the classroom environment. A flexible process was followed, which focused on understanding the participants' perspectives.

Research Design

The research design consisted of a case study. The case study is a qualitative research type that focuses on a specific program, case, or event (Merriam, 2009), and requires the inclusion of multiple data sources in order to provide an in-depth understanding (Creswell, 2009). In this study, P4C was presented as a case; data were obtained from three types of data sources: observations, interviews, and documents.

Planning the Process

The subject of the researcher's doctoral dissertation and the field of study is philosophy for children. The researcher determined the difficulties P4C practitioners experienced and identified the key features that differentiated P4C from other approaches. Apart from its distinctive problems during the application process of the teachers, P4C has the problems which the other non-traditional methods face. Managing the discussion process and asking questions about high-level thinking skills can be give as examples. The reasons for this problems include the use of traditional methods in teacher education and not having enough lessons which are based application. Thus, the basic features of P4C, the difficulties experienced by the teachers during the implementation of this course is the framework. The need for practice in teacher training is one of the factors shaping the course. For this reason, in the course, the application examples for P4C activities are given and then the teacher candidates design and apply their own activities. P4C activities are designed and applied. The course is also involved in linking P4C with the curriculum in order to provide an interdisciplinary perspective and to increase the applicability of it. The researcher proposed the P4C as an elective course and her proposal was accepted by the faculty of education.

The course can be taken by all students of the faculty of education because it is important that the student is a teacher candidate rather than in which department study at. The quota of the course was limited to 30 in order not to disrupt the discussion environment. The aim and content of the course was given to the students who wanted to choose the course. Thus, 30 volunteer students chose the course.

Participants

The study participants were 30 teacher candidates studying at a Turkish university during the spring of 2016. Twenty-nine of the participants were students in the elementary education department, and one was a student in the guidance and psychological counseling department. One of the elementary education students attending the four-year program was a senior, nine were juniors, and nineteen were sophomores. The psychological counseling and guidance student was a junior. One of the students was male; all others were female. The ages of the candidates ranged from 20 to 23 years. All elementary education students took the philosophy of education in the second year. However, psychological counseling and guidance student did not take this course.

Process

The course took place in the 14 weeks between February 16, 2016, and May 17, 2016. Thus, 30 volunteer students chose the course. The course took place in a classroom in the primary department of education building. The course was completed in 42 hours, 3 hours a week The relationship between philosophy and everyday life, theoretical knowledge regarding P4C, question analysis, principles of conducting debates, sample activities and related analysis, and strategies used in philosophizing with children were discussed in the process. During the implementation phase, the candidates selected an elementary school course and associated their plans with the goals or values involved in the curriculum. Groups of three planned a P4C lesson and applied it to their peers. The implementations were evaluated by discussion.

Data Collection Instruments and Data Collection Process

Observation. The researcher evaluated the teacher candidates' implementations through an observation form. The researcher did not use any standard or detailed observation form. The semi-structured observation form consisted of the following main titles: 'Presenting the Appropriate Stimulation', 'Determining the Basic Problem/Question', and 'Conducting a Debate'. These main titles are important for the implementation process of P4C. Therefore, they formed the basic framework of observation. The ten lesson plans prepared in three-people groups were administered by a group-appointed candidate; thus, ten prospective teachers were evaluated using the observation form.

The types of observation vary according to the researcher's role. In this research, the role of the researcher is the participant observer. The participant observer tries to collect information from the field as both observer and participant (Gold, 1958). In this method, research takes place in the natural environment in which the researcher participates in the environment (Yıldırım & Şimşek, 2013). In this study, the researcher is the person who conducts the course and collects the data as the participant observer.

Document. In this study, the observation documents consisted of self-assessment forms and by which each teacher candidate assessed him/herself, providing statements regarding his or her awareness of the subject at the end of a lesson. The self-assessment forms included the following open-ended questions:

1. What are your feelings and thoughts about the process of preparing a P4C plan?

2. At what stage were you challenged when preparing a P4C plan? Why?

3. What are the shortcomings in your plan? What would you do next time?

4. What do you think is the strongest part of your plan? Why?

5. What are your feelings and thoughts about the implementation process?

6. At what stage did you find it difficult to implement your plan? Why?

The documents also included ten P4C plans. The P4C process is flexible. The ambiguous course of discussion prevents detailed planning. In addition, a detailed plan limits the teacher. For this reason, P4C plans are shaped around main headings and possible discussion questions. Semi-structured plans consisted of the following headings: 'Objectives', 'Introduction and Discussion', and 'Evaluation Activities'. The plans were reviewed using the Lesson Plan Evaluation Form. With this form, the appropriateness of the achievements (inside and outside the program), introductive activities, questions (mostly philosophical questions), tools (mostly text) and evaluation activities were evaluated.

Interview. At the end of the fourteen weeks, eight of the volunteer candidates (all female; one being the guidance and psychological counseling student) were interviewed. Information on interviewed teacher candidates is presented in Table 1:

A semi-structured interview form was used to obtain their thoughts and feelings about the course. In the semi-structured interview, the questions are flexible, the majority of the interview consists of questions asked to be clarified, and there are no details of pre-determined expressions and questions (Merriam, 2009). The interview questions were as follows:

Table1. *Information on Interviewed Teacher Candidates*

Teacher Candidate (TC)	Age	Gender	Major	Class Level
TC 1	21	Female (F)	Psychological Counseling and Guidance	3
TC 3	21	F	Elementary Education	3
TC 4	22	F	(EE)	3
TC 10	22	F	EE	3
TC 13	20	F	EE	2
TC 18	20	F	EE	2
TC 29	23	F	EE	4
TC 30	21	F	EE	2

1. How do you evaluate the impact of P4C on feelings and thoughts? Why?

2. What do you say about the feelings and thoughts in the process of preparing activities for P4C? Why?

3. Can you benefit from P4C when you are a teacher? How?

4. What do you think about linking P4C with the curriculum?

5. What are the strengths and weaknesses of this course? Why do you think like this?

6. What are your suggestions for this course?

During the interviews with the students, the questions could be expressed differently according to the course of the conversation, the order of the questions changed, and new questions were added from time to time. Interviews took place in the classroom where the course was held. Each interview lasted an average of 30 minutes. Interviews were recorded with audio recorder.

Ethic. It is ethically important whether a research is worth doing and whether the research is useful (Punch, 2011). P4C is known by many countries around the world. The importance is increasing in Turkey. The studies also show that P4C positively affects students on social, cognitive and affective levels. The aim, content and research process of the course were explained to prospective teachers who wanted to take P4C course and asked to decide whether to take this course or not under these conditions. Thus, the volunteer candidates approved the process and took the course. During the interviews, the audio recorder was taken by having the permissions of the candidates. In addition, the names of the participants were kept confidential during the research and in the reporting of the research.

Data Analysis

Before the analysis process, observation notes, documents, and recorded audio interviews were transferred to computer. Having read the data once, irrelevant data were extracted. The researcher took notes while reading the data to help create themes. The data were analyzed by content analysis within the framework of the research questions determined based on the researcher's aim and assumptions. In qualitative research, data analysis includes data preparation, editing, coding data, combining codes, and finally presenting data in figures, tables, or discussion (Creswell, 2009). In this context, similar expressions in the data were coded and categorized according to any relation between them. Categories and themes were changed from time to time. In the process, both inductive and deductive ways were followed. Each category was grouped under main themes. Separate analysis of three data sources and their comparison after analysis are important for the validity of the research. Therefore, this process was carried out separately for the data obtained from each data source. Subsequently, the analysis results from different data sources were compared. The results of the analysis of the individual data sources were substantially paralleled. After that main themes gathered under research questions and were finalized.

Findings and Interpretation

Theme explanations are given below under each research question.

What is the Influence of the P4C Course on Teacher Candidates'…

'Perception of Philosophy?'. The teacher candidates stated that philosophy was related to their lives, that philosophy education was more than memorizing philosophers' views, that they could learn to philosophize, and that with the help of the P4C course, they understood that they had been unknowingly philosophizing. At the same time, they had an increased interest in philosophy. In the P4C course, philosophy's relation to daily life, similarities between philosopher and child, and the act of philosophizing were all addressed. The candidates had not previously contemplated these aspects of philosophy, as their previous coursework focused on history and philosophers' opinions. In addition, they did not encounter a course in the faculty of education other than the limited and theoretical educational philosophy. Even in some teacher, training programs (such as psychological counseling and guidance) there is no educational philosophy course. The P4C course thus changed the candidates' perceptions towards philosophy.

'Childhood Perception?'. Teacher candidates realized that children are capable of asking philosophical questions and that, with guidance, they could also provide logical answers to these questions. They shared their opinion that P4C could be used to better understand children. Traditional education regards children's minds as 'blank slate: teachers are responsible for transferring knowledge, and they approach children's reasoning capacities hesitantly. Teacher candidates are often presented with this traditional perception of childhood. At the end of the course, the candidates were surprised that the children asked philosophical questions, discussed them, and generated their own arguments. The candidates also thus began to question their own perceptions of children and childhood.

What are the Difficulties Faced by Teacher Candidates in Planning and Executing P4C?

'Asking Questions'. The teacher candidates stated that they experienced the greatest difficulty asking questions during the process of philosophizing with children in the analysis, synthesis, and evaluation stages. According to the candidates, associating the questions appropriately with the text and the concept discussed was challenging. The difficulty of generating unbiased questions which would not direct the children was also among the mentioned difficulties.

The candidates often discussed difficulty related to directing appropriate questions in the discussion process. Observation notes also reflected this problem. In addition to the above problems, the candidates experienced difficulties asking questions that would ensure reasoned thinking and promote a concept-oriented philosophy that would deepen the debate. The posing of insufficiently clear questions which were not thought-provoking but rather confirmed the children's own ideas constituted a problem in terms of the debate process. The candidates also recognized the importance of asking qualified questions. The candidates talked most about the importance of asking questions both abstract and concrete, and directing children to look at questions from different angles. The candidates' difficulties asking questions leading to higher-order thinking can be attributed to their personal epistemologies formed by their traditional learning and past experiences.

'Associating with the Curriculum'. Among the candidates' difficulties related to questioning, they also experienced difficulty associating philosophy with the curriculum. Although they found it meaningful to associate P4C with other courses, they had difficulty using philosophy to support curriculum goals. This can again be explained by the candidates' own traditional philosophical backgrounds, which impeded their ability to connect philosophy with other disciplines.

'Conducting a Debate'. Guiding a debate without ascertaining the truths in children's minds was another difficulty that the candidates faced. The observations revealed that the candidates experienced problems managing the debate process, in terms of encouraging participants to have conversations, ensuring clarity, and directing participants to discuss each other's views. There were also problems in deepening the debate, debating another question without deepening it, and ensuring that the debate continued. Practitioners who initiated discussion regarding concepts such as justice, responsibility, and truth, occasionally turned the P4C activities into values education that dictated 'right' behavior. This can be explained by the candidates' personal epistemologies based on knowledge transfer, which did not accept different perspectives and involved the absoluteness of truth.

The teacher candidates realized the role of their philosophical backgrounds in P4C education. This realization was often based on their observations regarding the debate process. They saw a close connection between having a philosophical background and asking thoughtful questions about concepts such as 'good–bad' and 'right–wrong', deepening debate, and addressing basic philosophical questions. The discussion processes of those who investigated the philosophical background of the concepts in which the activities took place were more productive. Others had difficulties asking philosophical questions, generating new questions during the debates, and asking questions that would promote different points of view. These challenges reduced the quality of the discussion process. At the same time, the practitioners could not tell which answers were more qualified, so they were unable to provide appropriate feedback. The inability to distinguish the quality of responses created the perception that each answer was valuable, preventing the emergence of answers that included thinking rightly as well as philosophical depth.

What are the views of teacher candidates regarding the involvement of P4C in the process of teacher education?

'Associating with the Curricula'. The candidates stated that it was possible to utilize P4C in every lesson, to deeply question concepts, foster critical thinking skills, generate conversation, and provide permanent learning by moving away from rote learning. The candidates also said that once they became teachers, they could utilize philosophy to connect disciplines and support the curriculum's goals.

'Preparing and Implementing Activities'. The teacher candidates designed P4C activities after viewing and analyzing sample activities. They then applied their activities to their peers. During the individual interviews, they noted that this method was useful. They discussed the value of noticing

their shortcomings in debate management and question generation. They observed that working collaboratively brought different perspectives. They also mentioned that the opportunity to apply theoretical knowledge was instructive. At the same time, the candidate's own attempts at philosophy occasioned them to reconsider their own debate skills.

'Evaluation'. A 'Teacher Candidate Lesson Plan Self-Assessment Form' and 'Teacher Candidate Lesson Plan Assessment Form' were used during the course. Open-ended evaluation questions were used at the end of the lesson. The lesson plan, the practices, and the nature of the questioning process were evaluated by discussion. During the interview, the candidates indicated that they observed inefficiencies in the evaluation activities and the evaluations on the applications.

Discussion and Conclusion

At the end of the P4C elective course, the candidates' interest towards philosophy increased, their perceptions changed, and they viewed children's thinking capacities anew. It can also be stated that their previous perceptions of children and their personal epistemologies negatively affected their processes of conducting debates and asking questions. It can be argued that their lack of a philosophical background led to difficulties associating philosophy with curriculum and in conducting debates. What were deemed as necessary in P4C lessons were the preparation, implementation, discussion, and evaluation of P4C activities, ultimately associating P4C with the curriculum.

The main activity of P4C is question-based debate. For this reason, the candidates in the P4C course encountered and analyzed many types of questions leading to higher-order thinking and philosophizing with children. They became aware of the question types, as well as questions, that might lead to higher-order thinking. Murris (2008) notes that in P4C, teachers learn to ask questions that will lead to philosophical debate.

In this study, one of the candidates' challenges was asking questions, a step in the process of philosophizing. They experienced difficulty preparing appropriate questions to facilitate higher-order thinking skills, promote philosophy, and deepen debates. Green and Condy (2016) reached similar conclusions in their P4C interviews with 30 elementary education teacher candidates. The candidates indicated that they found it difficult to ask philosophical, rather than factual, questions and that even if they had awareness of philosophical matters, they could not translate that awareness into their questions. Thus it can be seen that understanding the types of questions needed for philosophical instruction, and analyzing and preparing such questions, is of great importance when educating P4C teachers.

A lack of a philosophical background challenged the candidates' management of the debate process. P4C does not teach philosophical knowledge, nor does it offer content in the form of curriculum, but every inquiry carries philosophical concepts and questions. It is not a 'method without content' (Lewis & Robinson, 2017). Therefore, a philosophical background is needed to make an inquiry effective and connect it with the curriculum. Important aspects of philosophy—life relevancy, characteristics of philosophical discussion, and the main areas of philosophy—should be discussed in P4C teacher education. Such an approach, as seen in this study, also helps change the candidates' perceptions of, and increase their interest in, philosophy. Moreover, it supports the idea that P4C is not a method without content.

The teacher candidates' personal epistemologies and perceptions of childhood also impeded their ability to manage the debate process. Learning models based on transfer of knowledge prevented the candidates from creating an open dialogue that would allow them to approach questions from different perspectives and foster higher-order thinking. Lyle's 2014 study conducted on students and teachers from 64 schools supports this view. In his study, Lyle examined teachers' perceptions about childhood models. He concluded that teachers who cared about children's social skills employed P4C more frequently than those who defined children as 'innocent', 'bad', 'blank slate, and 'developing'.

This study shows that the P4C education changed candidates' perceptions of childhood, and increased their confidence in children's thinking capacities. There are also other studies indicating that P4C courses transform childhood perceptions and personal epistemologies. Scholl (2014) interviewed 14 elementary school teachers following a course in philosophy education. The teachers discussed the pedagogical models in their schools and stated that the teachers' perceptions of the models changed after the philosophy course. Some teachers expressed amazement regarding their students' knowledge and abilities. They have since come to understand that children can know and do, instead of seeing children as blank slate. Scholl, Nichols, and Burgh (2016), in their experimental work with fifty-nine elementary school teachers, observed that a philosophical inquiry-based education generated a pedagogical transformation in teachers.

In the course, the candidates were able to self-criticize their personal epistemologies and childhood perceptions. In interviews with prospective teacher candidates who took a P4C seminar, Demissie (2015) found that P4C directs candidates to reflectively consider information and pedagogy. The study shows that P4C provides a strong context in which to stimulate teacher candidates to utilize reflective thinking. Brownlee and Berthelsen (2008) argue that teachers' thinking processes about teaching practices increase by acknowledging that learning is a versatile and complex process. Therefore, teacher candidates should be encouraged to think critically and reflectively, and to express and develop their personal beliefs about their own learning and teaching. It is useful to provide an opportunity for pre-service teachers related to the self-reflection of instructional practices in the classroom as the way to develop knowledge and beliefs or maybe refine them in the future. (Purnomo, Suryadi & Darwis, 2016). These may include conducting sample discussion sessions and examining perspectives on children and learning. Moreover, self-assessment forms and diaries can be used to generate candidates' reflective thoughts.

Associating P4C with curricula was considered a challenge by the candidates. This difficulty may be due to their lack of philosophical knowledge and view of the link between philosophy and subjects of the curriculum. Nevertheless, the candidates found it important to associate P4C with curricula in terms of questioning concepts, deepening thinking, creating an open-dialogue, and establishing interdisciplinary relationships. According to Lewis and Robinson (2017), the P4C program teaches candidates not only to philosophize, but also to see the philosophical potential of curricular topics and develop ways to relate them to philosophical inquiry. For this reason, before considering P4C as a separate lesson, it is necessary to establish its association with the curriculum, and to ensure that educators establish this relationship. This will enable teachers to easily include philosophical arguments in their instruction (Wartenberg, 2009).

After the candidates analyzed the P4C activities, they noted the importance of activity preparation, and assessed the activities through implementation. The candidates stated that post-implementation assessment especially informed them regarding their deficiencies, aiding in self-improvement. Lipman (1988) mentions a similar three-stage model in P4C education. The first stage involves studying the P4C programs, in which the candidates discuss activities, as well as implement practices related to the activities. In the second stage, candidates observe an instructor's sample applications with children and apply the applications in their classes. Finally, the instructor observes the candidate and provides feedback. Here, Lipman notes the need for implementation and feedback, but includes ready-made activities.

Recommendations

The gains of the teacher candidates in the elective P4C course, the difficulties they experienced, and the recommendations they provided all offer ideas about P4C teacher education. Of course, teacher education involving critical, creative, and collaborative learning models, and a philosophy education that is based not on rote learning but is connected to life, will limit and change the content of P4C teacher education. Until changes are made, it is necessary to provide the parts omitted by the education system. Based on our findings, the following can be said regarding P4C teacher education:

• In teacher candidate education, the P4C course can change traditional perceptions of childhood and personal epistemologies.

• In order to create a philosophical background in P4C teacher education, skills such as philosophical question recognition and debate management should be included.

• Questions leading to higher-order thinking can be analyzed, and sample discussions and evaluation sessions on the nature of the discussion can be organized.

• Teacher candidates can prepare lesson plans by associating them with curricula instead of implementing ready-made activities. Activity application and feedback are critical components of P4C education.

• Opportunities for self-evaluation.

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Examination of The Students' Mistakes of Oral Reading

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Abstract

In this study, it is aimed to examine the level of oral reading of the students studying on their 3rd degree, who are at the age range of 60-66 months, and the students who completed their 72nd month and started primary school. The sample of the study is constituted of 100 students in the 3rd grade who study in primary schools Usak city center. 51 of the students are between the age range of 60-66 months. 49 of the students were recorded to be 72-months old. As a result of the study, it has been identified that the students who started primary school between the age range of 60-66 months made the mistake of oral reading by omitting the syllable and adding the syllable rather than the students who had completed their 72nd month. The students did not make the translation of the words at all. The students made the mistake of contemplating most at the level of concern. It was observed that starting the process of reading with open syllables decreased the mistakes of oral reading. It was determined that time dependent reading and emotional problems increase the mistakes of oral reading.

Keywords: Oral Reading, Oral Reading Mistakes, 60-66 Months-Old Students, 72 Months-Old Students

Introduction

Native language is an ability that a child acquires from her/his guardian and environment (Yıldız & Karataş, 2017; Sever, 2011). This ability is improved by acquiring the fields of listening, speaking, reading, writing and grammar fields actively. Especially the listening ability that contributes to the improvement of language both in an explicit and implicit way. (Emiroğlu, 2013). It is an ability that reveals what a student understands and strengthens the manner of expression. Reading involves a specific process. This process has multiple components and variables (Malu & Mcneal, 2017; Özfidan, 2017; Yangın, 1999; Özdemir, 1987). In this process, mother, father, guardian, friend, teacher and generally environment can be effective. Before the pre-school period, family involvement affects the process of reading whereas friends and teachers affect it in educational terms.

Significantly the attitudes of the classroom teachers are of great importance in the first reading and writing period. The attitudes and behaviours of the classroom teachers during oral reading can affect the speed of oral reading and reading comprehension of the students (Topping, 2014; Allington, 2014; Paige & Agpuri-Lavell, 2014). Time dependent competitions can be given as examples for the reason of the students to make reading mistakes during oral reading (Başar, Batur & Karasu 2014). In time dependent reading, the students try to utter a word correctly if they are able to recognize the word, and try to make up a definition or skip it if they do not recognize the word. This case can cause the students to make different reading mistakes.

In the body of the literature conducted, it has been observed that there has only been a limited number of studies conducted regarding the students starting school between the age range of 60-66 months and their oral reading mistakes (Bay & Anılan, 2015; Susar Kırmızı, 2015; Işık, 2014; Başar, 2013). Duran (2013) examined the writing abilities of the students who started primary school on their 60th month. It has been identified that the writing abilities of the students who started the school at the age range of 60-66 months were inadequate. Studies have been conducted on oral reading mistakes as well as the elimination of the mistakes. However, an applied and comparative study has not yet been found in the literature regarding the reasons of oral reading of both the students who start primary school between the ages of 60 and 66 months and the students who start primary school at the normal standard age. According to Begeney and Martens (2006), the studies on oral and silent reading should aim the enrichment of accurate vocabulary and improvement of voice recognition abilities as well as teaching the phonological features of language to first grade students in primary schools. In the second grade, studies should continue on the enrichment of vocabulary that the students have. Begeney and Martins stated that in the third grade, significant factors such as gradual acquisition of fluent reading abilities and the acquisition of the abilities of fast and accurate reading related to the text, accordingly, that the 3rd grade should be a period in which fluent reading studies should be emphasized. It is stated that the studies aiming at the acquisition of fluent reading and reading comprehension should be implemented in the fourth and fifth grades. Another reason for selecting the third grades is due to that the fluent reading studies are focused in this period as it is stated above. From this aspect, it is believed that the study will make a paramount contribution to the field.

Purpose

Answers were sought for the following sub-problems in this study in which the examination of oral reading mistake levels of the students who start primary school at the age range of 60-66 months and in their normal age.

1. What is the frequency level of observing the oral reading mistakes of the third grade students in primary schools?

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2. Oral reading mistakes of the students are based on;

a. Starting age at primary school between the ages of 60-66 months and after completing the 72nd month,

b. Gender,

c. Method of conducting the process of writing in primary school with open/closed syllable,

d. Status of students receiving support out of school hours,

e. Status of the classroom teachers receiving an expert consultancy in the period of the first reading and writing process,

f. Status of the students having emotional troubles,

g. Status of time dependent oral reading,

h. Duration of completing the first reading and writing periods,

i. Period of reading the text,

j. Does it become different according to the forming of the classrooms?

Method

This study is within the scope of the descriptive survey model since the purpose is to identify the present situation. Survey models are the approaches that aim to describe an event taken place in the past or which is still ongoing in its existing form. A matter, individual or object in the study are attempted to be identified within their own conditions as they exist. Efforts are not made to change or affect anything in any manner (Karasar, 2011).

Population

The population of the study is composed of 3rd grade students who study in primary schools, subject to the Ministry of National Education, in Uşak province in the academic year of 2014-2015.

Sample

The sample of the study is composed of 100 students in the 3rd grade who study in primary schools on each two schools that have low, intermediate and good socio-economic levels in Usak city center in the 2014-2015 academic year. In this way, maximum amount of variety has been provided. 57 of the students in the study are female and 43 of them are male who took part in the sample of the study. 51 of the students are between the age range of 60-66 months and 49 of whom are students who started the primary school at their normal standard age. 18 of the students took part with the students who are between the age range of 60-66 months and with the students who started the school at their normal age. 33 students continued to receive education only in the classroom with the students who are at the age range of 60-66 months. 44 of whom are students of the school having the low level of socio-economic environment, 21 of them are the students of the school having the intermediate level of socio-economic environment and 35 of them are the students of the school having the good level of socio-economic environment.

Study Model and Data Collection Tool

In the study, the model is based on the researcher, and the subject researched. The researcher selects the appropriate model in accordance with the subject in order to obtain reliable data related to the subject she/he will do research on. The appropriate model is significant for the study. The trial model has been used in the study due to its convenience. Trial models involve the production of the data that is desired to be observed under the control of the researcher with the purpose of identifying the cause-effect relationship (Karasar, 2011). According to Büyüköztürk et.al. (2010), survey researches are the studies which are generally conducted on larger samples compared to other studies, where features such as interest, ability, talent, attitude etc. of the participants on a certain subject or event are focused on. "Anatolia" piece which is composed of 184 words and 421 syllables has been selected as the data collection tool.

Data Analysis

The data of this study in which the oral reading mistake levels are aimed to be examined among the students who completed the age range of 60-66 months as well as those who completed the 72nd month then started the primary school and going on to the 3rd grade, have been evaluated with the use of the SPSS program. Karasar (2011), in accordance with the objectives of the data research period, described the analysis of the data as determining the fundamental elements and features. Frequency and percentage tests have been implemented in order to identify the frequency of oral reading mistakes. Age range, gender, starting the first reading-writing process with open or closed syllable, the student's status on receiving external support, the classroom teachers' status of receiving consultancy, whether the classroom teachers have emotional problems and the differentiation depending on the status of time dependent reading have been evaluated with the *t*-test method. In order to determine the difference between the period of completing the first reading-writing process, duration of reading the text and the method of composing the classrooms, the ANOVA (*F*) test has been implemented. Regression analysis has been conducted in order to identify the impact of the independent variables upon the dependant variable, and to determine the relationship between them.

Implementation Process

The children between the age range of 60-66 months also started the school beginning from 2012-2013 academic year with the act that was published in the official newspaper dated July 20, 2012 and serial numbered 26263. The students who began the school on this date, had their 3rd year of education as of 2014-2015 academic year. Some of these students received education in classrooms composed of students who started the primary school between the age range of 60-66 months, and some of them received coed-education with students who started the school at the normal standard age. Only the classrooms in which the students receiving education at the age range of 60-66 months have been identified in the primary schools in Usak city center. Interviews have been carried out with the teachers in these classrooms. The students volunteered to take part in the study, studying in the classrooms, as well as three volunteer classroom teachers who volunteered to take part in the study, have been included in the sample of the study. In the same way, other groups of students were also incorporated in the study using the same method. Throughout the study, attention was paid to the use of reading text which are not part of the syllabus across schools in Usak city center. In this context, "Anatolia" piece which is composed of 184 words and 421 syllables has been selected as the data collection tool. In the classrooms where the study was conducted, the teachers were asked whether or not the text was convenient, with a later result stated by teachers that it had relevance. Then, the views of three experts in the branches of classroom teaching and Turkish teaching for the convenience of the reading text were shared. The implementations were initiated after the experts had stated their opinions. The negotiations were made with the directors in the school and the students were asked to read out the text aloud after the relevant students were taken into a room individually. The students were not able to hear what other students said in the activity and they were enabled not to be distracted by each other. Two minutes of speech were made with the students in order for them not to be affected by the environment negatively. In this way, the necessary surrounding was established in order for students not to become apprehensive or shy. Mistake frequency of the students were identified by marking down each mistake that the students made, among the 18 oral reading mistakes that were determined in Başar, Batur and Karasu, (2014) study while the text was read out by the students. Another researcher followed the reading time of the student without being informed. In this way, it was desired to examine the impact of the student's time of reading the text upon the oral reading mistakes without creating pressure. Reading mistakes of the students were coded as free, acceptable and concern level. The coding was developed by the researchers by utilizing from "False Analysis Inventory" that was prepared by Akyol, (2012), Haris and Spay, (1990), Ekwal Shanker (1988) and May (1986). Some personal information of the independent variables of the study were collected from the teachers.

Findings

Findings Related to the First Sub Problem

Table 1. *Percentage (%) Frequency (f) Results of Oral Reading Mistakes*

Oral Reading Mistakes	Free F	%	Acceptable f	%	Concern Level f	%
Repeating	59	59	22	22	19	19
Contemplating	38	38	24	24	38	38
Interruption	77	77	18	18	5	5
Omitting the Syllable	57	57	19	19	24	24
Adding the Syllable	80	80	12	12	8	8
Mixing the Sounds	97	97	3	3	0	0
Adding Sound	90	90	8	8	2	2
Not Being Able to Control Breathing	90	90	4	4	6	6
Skipping	96	96	1	1	3	3
Reading With Local Dialect	98	98	2	2	0	0
Non-conformity to Orthographic Rules	84	84	8	8	8	8
Translation of the Syllable	95	95	5	5	0	0
Separating the Syllable Wrongly	89	89	2	2	9	9
Translation of the Word	100	100	0	0	0	0
Extending	99	99	1	1	0	0
Not Being Able to Make Sound	99	99	1	1	0	0
Reading by Bending	74	74	2	2	24	24
Following with Hand or Pencil	74	74	3	3	23	23

Oral reading mistakes of the students were given as frequency and percentage in Table 2. Oral reading of the students was considered to be free reading level, acceptable level and concern level as can be seen in Table 1. The mistake of translation was recorded to be the word having the highest frequency in the free reading level. In this study, translation mistakes of the students were not identified. Having the highest frequency both at acceptable level and concern level is the mistake of contemplating. It is the reading of the word by students by contemplating the word according to the first syllable. The students made the mistake of contemplating while reading the long words having larger syllables which do not take part in the schema of the students. "Bakrac" (bucket), "batara" (water bottle), "oluğa" (towards the groove) and the word "Turkcelesmistir" (it has been made Turkish) are the words that the students made the mistake of contemplating on most. 38% (*n*= 38) of the students made oral reading at free level whereas 38% (*n*= 38) of them made oral reading at concern level. Another mistake having a high frequency of concern is the mistake of omitting the syllable, where 24% (*n*= 24) of the students who took part in the sample made this mistake. The students made the mistake of omitting the syllable most in "mataraları" (water bottles) by omitting "ra" syllable and in "ileride" (in the future) by omitting "de" syllable. Once again, 24% (*n*= 24) of the students made the mistake of reading the text by bending, 23% (*n*= 23) of them made the mistake of following the text with hand or pencil. The students make the mistakes of reading the text by bending, with hand or by following with pencil. The mistakes of mixing the sounds, reading with local dialect and translation of syllable, translation and extension of words and not being able to make sound have not been identified at the level of concern.

Findings Related to the Sub Problem 2a

Table 2. *Differentiation t-test in the Mistakes of Oral Reading Depending on Age*

Oral Reading Mistakes		n	Mean	SD	df	t	p
Omitting the Syllable	60-66 Months	51	2.02	.904	86.783	5.626	.018
	Normally	49	1.23	.476			
Adding the Syllable	60-66 Months	51	1.43	.735	75.276	3.139	.024
	Normally	49	1.09	.291			

A difference was identified between the mistake of syllable omitting and syllable adding when it comes to the relationship between the students starting primary school between the age range of 60-66 months and the students who started the school at their normal age according to Table 2 ($p<$ .05). The students who started primary school between the age range of 60 and 66 months make the mistake of syllable omitting and syllable adding rather than the students who started the primary school at their normal age.

Findings Related to the Sub Problem 2b

According to the *t*-test which was conducted to measure the oral reading mistakes depending on genders, no difference was found between the genders regarding oral reading mistakes of the students.

Findings Related to the Sub Problem 2c

The mistake differences were examined whether students started the first reading and writing processes with closed or open syllabus in Table 3. A substantial difference was found in the mistakes of repeating, interruption, omitting the syllable, adding the syllable, not being able to control breathing, non-conformity to nonorthographic rules, separating the syllable wrongly, reading by bending, and following with hand or pencil (p< .05). The students who started the primary school writing process with a closed syllable made more oral reading mistakes than the students who started the primary school writing process with an open syllable.

Table 3. *Differentiation t-test in Oral Reading Mistakes Depending on the Starting of Writing with Open/Closed Syllable in Primary School*

Oral Reading Mistakes		*n*	Mean	*SD*	*df*	*t*	*p*
Repeating	Close	75	1.77	.831	97.988	4.083	.000
	Open	25	1.08	.277			
Contemplating	Close	75	2.28	.817	88.287	9.317	.000
	Open	56	1.16	.374			
Interruption	Close	75	1.36	.607	98.000	3.964	.000
	Open	25	1.04	.321			
Omitting the Syllable	Close	75	1.81	.881	70.430	3.961	.000
	Open	25	1.24	.521			
Adding the Syllable	Close	75	1.37	.673	74.000	4.802	.000
	Open	25	1.00	.000			
Not Being Able to Control Breathing	Close	75	1.21	.576	74.000	3.255	.002
	Open	25	1.00	.000			
Non-conformity to Orthographic	Close	75	1.32	.661	74.000	4.193	.000
	Open	25	1.00	.000			
Separating the Syllable Wrongly	Close	75	1.27	664	74.000	3.476	.001
	Open	25	1.00	000			
Reading by Bending	Close	75	1.64	925	91.500	4.197	004
	Open	25	1.08	400			
Following with Hand or Pencil	Close	75	1.65	925	74.000	3.529	.001
	Open	25	1.00	400			

Table 4. *Multivariate Regression Analysis Results Starting of Writing with Open/Closed Syllable in Primary School*

Oral Reading Mistakes	*B*	SH_B	*B*	*t*	*p*
Constant	2.637	.318		8.295	.000
Repeating	-.071	.051	-.129	-1.388	.169
Contemplating	-.234	.049	-.471	-4.806	.000
Adding the Syllable	.037	.107	-.051	-.076	.566
Adding Sound	.133	.063	.117	1.245	.094
Separating the Syllable Wrongly	.107	.044	-.143	-1.689	.095
Reading by Bending	.075	.046	.147	-1.431	.156
Following with Hand or Pencil	.065	.076	.127	-.304	.762
Interruption	.023	.073	-029	-1.299	.197
Not Being Able to Control Breathing	.094	.102	-110	-2.507	.564
Skipping	-.256	.266	-.209	-.579	.014

n= 100, R= .687, R^2= .472, F= 7,153 p< .01

Multiple regression analysis, which is related to the association of starting the first writing and reading process with open or closed syllabus with oral reading mistakes, take part in Table 4. Acquisition of the ability of reading the open or closed syllabus have a great importance on mistake types such as contemplating and skipping. (R= 687, R^2= .472, p< .01). Starting with the first writing and reading process with open or closed syllabus accounted for 47% of oral reading mistakes. When t-test results, which are related to the relevance of the regression coefficients were evaluated, it was observed that conducting open or closed syllable has a predicting role in the mistakes of contemplating and omitting the syllable.

Findings Related to the Sub Problem 2d

Table 5. *Differentiation t-test Depending on the Students Receiving Support at Home or Not in Oral Reading Mistakes*

Oral Reading Mistakes		*n*	Mean	*SD*	*df*	*t*	*p*
Repeating	Yes	26	1.08	.272	97.746	-4.241	.000
	No	74	1.78	.832			
Contemplating	Yes	26	1.23	.430	84.249	-6.401	.000
	No	74	2.27	.833			
Interrupting	Yes	26	1.04	.196	97.606	-2.673	.000
	No	74	1.36	.610			
Omitting the Syllable	Yes	26	1.23	.514	75.624	-3.239	.002
	No	74	1.86	.881			
Adding the Syllable	Yes	26	1,00	.000	73.000	-2.843	.005
	No	74	1.38	.676			
Not Being Able to Control Breathing	Yes	26	1.00	.000	73.000	-1.895	.002
	No	74	1.22	.580			
Non-conformity to Orthographic	Yes	26	1.00	.000	73.000	-2.481	.001
	No	74	1.32	.664			
Separating the Syllable Wrongly	Yes	26	1.00	.000	73.000	-2.056	.001
	No	74	1.27	.668			
Reading by Bending	Yes	26	1.08	.392	94.653	3.090	.004
	No	74	1.65	.928			
Following with Hand or Pencil	Yes	26	1.00	.000	73.000	3.635	.000
	No	74	1.66	.926			

The oral reading mistakes of the students who received supported educationat home as well as those who did not have been evaluated. The students not receiving support on reading at home, made the mistakes of repeating, contemplating, interrupting, omitting the syllable, adding the syllable, not being able to control breathing, non-conformity to non-orthographic rules, separating the syllable wrongly, reading by bending, and following with hand or pencil are more than the students who received support at home (p< .05).

Table 6. *Multivariate Regression Analysis Results Among the Students Who Received Support Education at Home and Invariables*

Oral Reading Mistakes	*B*	SH_B	*B*	*t*	*p*
Constant	-.286	.700		-.409	.684
Repeating	-.088	.056	.157	1.572	.120
Contemplating	.043	.059	.392	3.367	.001
Adding the Syllable	.038	.074	.052	.515	.608
Omitting the Syllable	.032	.057	.061	.559	.578
Separating the Syllable Wrongly	.092	.073	.123	1.256	.213
Skipping	.264	.110	.213	2.399	.019
Interrupting	.023	.073	-029	-1.299	.197
Not Being Able to Control Breathing	.073	.084	.085	.877	.383
Following with Hand or Pencil	-.256	.266	-.209	-.579	.564

n= 100, R= .684, R^2= .468, F= 4,249 p< .01

There is a multiple regression analysis in Table 6 related to the association of receiving/or not receiving the support education at home with oral reading mistakes. There is a strong relationship between time dependent oral reading mistakes and oral reading mistakes. (*R*= 684, R^2= .468, *p*< .01). Time dependent oral reading explains for 47% of the oral reading mistakes. When *t*-test results, which are related to the relevance of the regression coefficients, were evaluated, it has been observed to be a predictor in the mistakes of receiving support at home/or not, contemplating and skipping.

Findings Related to the Sub Problem 2e

Table 7. *Differentiation t-test in the Mistakes of Oral Reading Depending on the Teachers Receiving Consultancy/ or not*

Oral Reading Mistakes		n	Mean	*SD*	*df*	*t*	*p*
Repeating	Yes	25	1.08	.277	97.988	-4.083	.000
	No	75	1.77	.831			
Contemplating	Yes	25	1.20	.408	83.781	-6183	.000
	No	75	2.27	.827			
Interruption	Yes	25	1.04	200	98.000	-2.581	.000
	No	75	1.36	.607			
Omitting the Syllable	Yes	25	1.20	.500	73.312	-3.391	.000
	No	75	1.83	.876			
Adding the Syllable	Yes	25	1,00	.000	74.000	-2.763	.001
	No	75	1.38	.576			
Not Being Able to Control Breath	Yes	25	1.00	.000	74.000	-1.844	.002
	No	75	1.21	.673			
Non-conformity to Orthographic	Yes	25	1.00	.000	74.000	-2.413	.001
	No	75	1.32	.661			
Separating the Syllable Wrongly	Yes	25	1.00	.000	74.000	-2.000	.001
	No	75	1.27	.664			
Reading by Bending	Yes	25	1.08	.000	74.000	3.554	.001
	No	75	1.67	.935			
Following with Hand or Pencil	Yes	25	1.00	.000	74.000	3.529	.001
	No	75	1.65	.923			

The difference whether to receive consultancy support from an expert or not has been examined in the stage of primary school for classroom teachers. The students who started the writing process with the closed syllable made the mistakes of repeating, contemplating, interrupting, omitting the syllable, adding the syllable, not being able to control breathing, non-conformity to nonorthographic rules, separating the syllable wrongly, reading by bending, and following with hand or pencil are more than that of the students who started the writing process with an open syllable (*p*< .05).

Table 8. *Multivariate Regression Analysis Results of the Classroom Student Among the Receiving Expert Consultancy and Oral Reading Mistakes*

Oral Reading Mistakes	*B*	SH_B	*B*	*t*	*p*
Constant	-239	.680		.351	.726
Contemplating	.203	.057	.408	3.557	.001
Skipping	.267	.107	.218	2.494	.015
Reading by Bending	.125	.048	-.246	2.588	.011

n= 100, R= .686, R^2= .484, F= 4,529 p< .01

There is a multiple regression analysis in Table 8 related to the association of the classroom teachers receiving/or not receiving the expert consultancy with oral reading mistakes. The classroom teachers receiving an expert consultancy during the first writing process have a substantial influence upon contemplating, skipping and reading by bending. (*R*= .686, R^2= .484, *p*< .01). Receiving an expert consultancy/or not in the first writing and reading period accounts for 48% the oral reading mistakes. When *t*-test results, which are related to the relevance of the regression coefficients, were evaluated, it was observed that receiving a consultancy service/or not, have a predicting role in the mistakes of contemplating and reading by bending.

Findings Related to the Sub Problem 2f

Table 9. *Differentiation t-test on the Oral Reading Mistakes Depending on Emotional Problems*

Oral Reading Mistakes		*n*	Mean	*SD*	*df*	*t*	*p*
Repeating	Yes	41	1.86	.843	77.691	2.200	.030
	No	59	1.42	.727	83.636	3.420	.001
Contemplating	Yes	41	2.34	.855	53.186	3.291	.005
	No	59	1.76	.817	68.660	4.031	.000
Interruption	Yes	41	1.49	.711	65.341	2.603	.011
	No	59	1.14	.345	40.000	4.033	.000
Omitting the Syllable	Yes	41	2.05	.921	44.186	4.165	.000
	No	59	1.41	.673.	48.601	2.798	.006
Adding the Syllable	Yes	41	1.46	.711	67.228	2.817	.006
	No	59	1.15	.485	65.048	3.528	.001
Adding Sound	Yes	41	1.29	.559	77.691	2.200	.030
	No	59	1.00	.000	83.636	3.420	.001
Non-conformity to Orthographic	Yes	41	1.51	.810	53.186	3.291	.005
	No	59	1.05	.222	68.660	4.031	.000
Separating the Syllable Wrongly	Yes	41	1.39	.802	65.341	2.603	.011
	No	59	1.07	.314	40.000	4.033	.000
Reading by Bending	Yes	41	1.78	.988	44.186	4.165	.000
	No	59	1.31	.401	48.601	2.798	.006
Following with Hand or Pencil	Yes	41	1.83.	.972	67.228	2.817	.006
	No	59	1.25	.659	65.048	3.528	.001

Emotional problems are the problems such as division of family, death of mother, father or both of them, being subjected to violence, or experiencing an accident. The students who have one or more of these problems make the mistakes of repeating, contemplating, interrupting, omitting the syllable, adding the syllable, not being able to control breathing, non-conformity to nonorthographic rules, separating the syllable wrongly, reading by bending, following with hand or pencil more than the students who did not have these emotional problems (*p*< .05).

Table 10. *Multivariate Regression Analysis Results Among Having an Emotional Problem and Variables*

Oral Reading Mistakes	*B*	SH_B	*B*	*t*	*p*
Constant	4.238	.756		5,603	.000
Omitting the Syllable	-.130	.062	-.221	-2.908	.039
Mixing the Sounds	-.527	.129	-.139	-2.008	.048
Skipping	-.308	.119	-.221	-2.587	.011
Reading by Bending	-.163	.054	-.283	-3.044	.003
Following with Hand or Pencil	-.161	053	-.276	-3.015	.003

In table 10, Multiple regression analysis exists, which is related to the association of the emotional problems such as family division that the student experienced or is currently experiencing in Table 10, death of mother, father or both of them, encountering an accident, being subjected to violence, with the oral reading mistakes. Having an emotional issue has an immense effect upon the mistakes such as omitting the syllable, mixing and skipping the sounds, and following with hand and pencil. (*R*= .711, R^2= .506, *p*< .01). Emotional problems accounts for 51% of oral reading mistakes. When *t*-test results, which are related to the relevance of the regression coefficients, were evaluated, it was observed that these results have a meaningful predictor on omitting the syllable, mixing and skipping the sounds, reading by bending, and following by hand or pencil.

Findings Related to the Sub Problem 2g

Table 11. *Differentiation t-test in the Mistakes of Time Dependent Oral Readings*

Oral Reading Mistakes		*n*	Mean	*ss*	*SD*	*t*	*p*
Repeating	Yes	56	1.88	.875	89.293	4.523	.000
	No	44	1.25	.488			
Contemplating	Yes	56	2.38	.822	97.356	5.603	.000
	No	44	1.52	.698			
Interruption	Yes	56	1,41	.654	83.798	2.972	.007
	No	44	1,11	.321			
Omitting the Syllable	Yes	56	2.02	.904	86.783	5.626	.000
	No	44	1.23	.476			
Adding the Syllable	Yes	56	1.43	.735	75.276	3.139	.000
	No	44	1.09	.291			
Not Being Able to Control Breath	Yes	56	1.27	.646	62.495	2.744	.008
	No	44	1.02	.151			
Non-conformity to Orthographic	Yes	56	1.39	.731	66.311	3.384	.003
	No	44	1.05	.211			
Separating the Syllable Wrongly	Yes	56	1.89	.985	55.000	6.784	.000
	No	44	1.00	.000			
Reading by Bending	Yes	56	1.86	.980	58.213	6.276	.000
	No	44	1.02	.151			
Following with Hand or Pencil	Yes	56	1.86	.980	58.213	6.276	.000
	No	44	1.02	.151			

In the table, a couple of words were read in a couple of minutes, and the impact of time dependent reading on the reading mistakes have been revealed. The students who made time dependent by their teachers or families, mistakes of repeating, contemplating, interrupting, omitting the syllable, adding the syllable, not being able to control breathing, non-conformity to nonorthographic rules, separating the syllable wrongly, reading by bending, and following with hand or pencil are more than the students who did not.

Table 12. *Multivariate Regression Analysis Results Among Time Dependent Reading and Oral Reading Mistakes*

Oral Reading Mistakes	*B*	SH_B	*B*	*t*	*P*
Constant	2.562	.0998		26.047	.000
Omitting the Syllable	-.249	.038	-.419	-6.416	.000
Reading by Bending	-.244	.038	-.420	-6.416	.000
Following with Hand or Pencil	.229	-.039	-.388	-5.936	.000

n= 100, R= .778, R^2= .605, F= 49,009 p< .01

Multiple regression analysis which is related to the association of time dependent reading with the oral reading mistakes in Table 12. Reading based upon the time dependent method, has an important impact on the mistakes such as omitting the syllable, reading by bending, and following by hand and pencil. (*R*= .778, R^2= .605, *p*< .01). Time dependent oral reading accounts for 61% of oral reading mistakes. When *t-test* results, which are related to the relevance of the regression coefficients were examined, it was observed that time dependent reading is a predictor on the mistakes such as omitting the syllable, reading by bending, and following by hand or pencil.

Findings Related to the Sub Problem 2h

An anova test was performed in order to examine the impact of the students' completion time of reading and writing upon the oral reading mistakes in Table 13. The oral reading mistakes of the students vary on the level of *p*< .05 depending on the completion time of the first reading and writing of students. A substantial difference has been found in the mistakes of contemplating, interrupting, omitting the syllable, adding the syllable, separating the syllable wrongly and bending depending on the time of reading the text. The Ministry of National Education states that the first reading and writing process in the 2005 program as the second term of December and the last week of March. In the Tukey test, which was implemented in order to identify the source of difference, the students who completed the first reading and writing period after the normal time made the mistakes of contemplating, interrupting and omitting the syllable more than that of the students who completed it on the normal time and before the normal time. The students who completed the first reading and writing process before the normal time, made the mistake of adding the syllable more than the students who completed it in the normal time. The students who completed the first reading and writing process before and after the normal time, made the mistake of separating the syllable wrongly more frequently than the students who completed it in the normal time. The students who completed the first reading and writing process after the normal time, make the mistake of reading by bending more regularly than the students who completed the first reading and writing process in its normal time

Findings Related to the Sub Problem 2i

A substantial difference was found in the Anova test in order to reveal the difference between students' period of reading the text and oral reading mistakes (p< .05). The Tukey test was carried out in order to identify the source of the difference. As the reading time of the student increases, so does the frequency of repeating mistake. Once again, as the students' time of reading increases, do does the frequency of making the interrupting mistake. However, no difference was found between the times of reading the text in and under two minutes and other oral reading times. Fast reading does not have any contribution to decreasing the recurrance of mistakes. As the reading times of the students increases, the mistake of omitting the syllable also rises. Once again, speedy reading does not decrease the probability of omitting the syllable mistake. As the students' reading time of the text increases, so does the mistake level of adding sound. The students whose reading times were between 3.01 and 4 minutes made the mistake of non-conformity to nonorthographic rules more than the students whose reading times were between 2.31 and 3 minutes. The students whose reading times were between 3.01 and 4 minutes made the mistake of separating the syllable wrongly more than the students whose reading times were between 2.31 and 3 minutes.

There is a multiple regression analysis in Table 15, which is related to the identification of oral reading mistakes. Occupation of father, educational background of father, occupation of mother, educational background of mother, status of income, period of completing the first reading and writing process, socio-economic status of the school do not have an

Table 13. *Differentiation in Oral Reading Mistakes Depending on the Completion Times of Reading and Writing*

Oral Reading Mistakes	Resource of Difference	Sum of Squares	*df*	Mean Square	*F*	*p*	Mean Difference I-J
Contemplating	Between Groups	3.512	2	5.790 .537	8.718	.000	ANT>ONT ANT>BNT
	Within Groups	51.041	97				
	Total	62.000	99				
Interrupting	Between Groups	5.237	2	2.618 .257	10.191	.000	ANT>ONT ANT>BNT
	Within Groups	22.460	97				
	Total	30.160	99				
Omitting the Syllable	Between Groups	9.918	2	2.479 .634	4.440	.000	ANT>ONT ANT>BNT
	Within Groups	60.192	97				
	Total	70.110	99				
Adding the Syllable	Between Groups	2.968	2	2.469 .383	6.446	.017	BNT>NS
	Within Groups	33.192	97				
	Total	36.160	99				
Separating the Syllable	Between Groups	2.550	2	1.275 .324	3.932	.002	BNT>ONT ANT>ONT
	Within Groups	31.450	97				
	Total	34.000	99				
Reading by Bending	Between Groups	5.248	2	2.624 .698	3.756	.002	ANT>ONT
	Within Groups	67.752	97				
	Total	73.000	99				

BNT= Before normal time, ONT= On normal time, ANT=After normal time:

Table 14. *Differentiation in Oral Reading Mistakes Depending on the Completion Times of Reading and Writing*

Oral Reading Mistakes	Resource of Difference	Sum of Squares	*df*	Mean Square	*F*	*p*	Mean Difference I-J
Repeating	Between Groups	10.498	4	2.740 .537	5.099	.001	4.01 and abo.> 2.01-2.30 4.01 and abo.> 2.31-3.00 3.01-4.00> 2.01-2.30
	Within Groups	51.041	95				
	Total	62.000	99				
Interrupting	Between Groups	7.760	4	1.940 .236	8.228	.000	4.01 and above> 0-2,00 4.01 and abo.> 2.01-2.30 4.01 and above > 2.31-3.00 3.01 -4.00> 2.01-2.30 3.01-4 > 2.31-3.00
	Within Groups	22.460	95				
	Total	30.160	99				
Omitting the Syllable	Between Groups	9.918	4	2.479 .634	4.440	.006	4.01 and abo.> 2.01-2.30 3.01 -4.00i> 2.31-3.00
	Within Groups	60.192	95				
	Total	70.110	99				
Adding Sound	Between Groups	2.549	4	2.469 .383	6.446	.002	4.01 and above> 0-2,00 4.01 and above > 2.01-2.30 4.01 and abo.> 2.30-3.00
	Within Groups	70.260	95				
	Total	72.819	99				
Non-conformity to Orthographic	Between Groups	4.798	4	1.200 .310	3.870	.006	3.01 -4.00> 2.31-3.00
	Within Groups	29.4422	95				
	Total	34.240	99				
Separating the Syllable	Between Groups	4,851	4	1.213 .307	4.440	.006	3.01 -4.00> 0-2,00 3.01 -4.00> 2.31-3.00
	Within Groups	29.149	95				
	Total	34.000	99				

0-2 : Reading the text in less than two minutes; 2.01-2.30: Reading the text within two minutes or between two minutes and thirty seconds; 2.31-3: Reading the text within 2 minutes or between 31 seconds and 3 minutes; 3.01-4:Reading the text within 3.01 and 4 minutes; 4.01 and above: Reading the text in more than four minutes

significant impact upon the mistakes of oral reading. (*R*= 487, R^2= 237, *p*< .01) The relevant variables only account for 24% of oral reading mistakes.

Table 15. *Multivariative Regression Analysis Result Among the Variables*

Oral Reading Mistakes	*B*	*SHB*	*β*	*t*	*p*
Constant	.891	.554		1.607	.111
Period of completing the first	.392	.167	.265	2.351	.021
Text Reading Time	.067	.088	.084	.767	.445
Socio-economic status	.146	.116	.148	1.255	.213

n= 100, R= .487, R^2= .237, F= 3,531 p< .01

Findings Related to the Sub Problem 2k

The mistakes of the students do not vary according to the method of forming the classrooms. Coexistence of the students in mixed classrooms and the students who are at the age of 60-66 months do not affect oral reading mistakes of the students.

Conclusion

Reading is a different type of development among the other native language abilities as it takes longer for students to acquire both vocal and silent reading abilities. So reading involves a certain process (Al Farsi, 2018; Kearns; Rogers

& Koriakin, 2016; Tabačková, 2015). This skill is a complex process (Joyce, Hood & Rose, 2008; Zera & Lucian, 2001; Jeffrey, 2000;). Reading is an activity that involves comprehension and interpretation (Shea & Ceprano, 2017; Akyol, 2011; Yangın, 2002; Öz, 2001; Güneş, 2000; Zhang, 1999; Bamberger, 1990). This study especially focused on oral reading implementations. Classroom teachers conduct various studies in order to increase the level and speed of the students. Oral reading mistakes have been identified in this study, and contemplating and omitting the syllable are the mistakes the students made most during the reading sessions. The students who started the primary school between the age range of 60-66 months have been recorded to have made more mistakes than the students who had completed their 72 month when starting school. This circumstance can be linked with that the students at the age range of 60-66 months cannot discern the abstract rules of the language completely and not being able to form a relationship between oral reading and speaking rules. It has been identified that the students who started the first reading and writing with a closed syllable make more mistakes than the students who started the first reading and writing with an open syllable. Open syllables have been effective in oral reading since it is convenient for the logic of langauge. The study which was conducted by Başar et.al., (2015) supports this finding. In their study, Başar, et. al., concluded that the oral reading decreases among students who conduct the first reading process with an open syllable. The students who did not receive support at home made more mistakes than the ones who received support. The students can develop their ability of reading by practicing at home. The teacher who received the expert support has been recorded to have made less reading mistakes than the students whose teacher did not receive support. The teachers adopt a positive attitude towards the students during the oral reading and this reveals the importance of the experts. The students who had or were experiencing emotional problems made more mistakes than other students. This can be linked to the family problems that the students cannot learn and focus on the words completely. In this regard, recognizing the word affects the reading fluency positively (Yamaç, 2014; Dağ, 2010). Razon (2007) states that emotional problems affect the reading abilities of the students negatively. The students who delivered time dependent reading make more mistakes than those students who delivered without time dependent reading. This case might have taken place due to the students focusing on uttering the words rapidly instead of patiently and correctly, as well as the pressure that the students felt based on the time period that they were exposed to. Başar et.al., (2014) identified that the time dependent reading studies have a negative impact upon reading and comprehension as it increases the reading mistakes. The educational background and socio-economic status of the family has an impact upon oral reading. It is seen that as the educational background of the family recovers, so does the number of oral reading mistakes of the students. This circumstance overlaps the studies of Dökmen (1994) and, Topçuoğlu and Yigit (2014) related to the impact of the family upon reading ability. As long as the time given to reading increases, so does the number of mistakes during the reading activity. (This is because the students distract their attention gradually and they focus on reading fast and vocalizing and their mistakes increase. This also coincides with similar studies (Blackwell, 1962; Dudley & Mather, 2005; Genovese, Pellegrini, & Geraci, 2007; Tsvetkova, 2017). The number of mistakes increases as the time given for reading increases, and the number of mistakes increase as the time given for reading decreases. It can be stated that reading a text speedily does not make the relevant student good at reading a text. In conclusion, oral reading mistakes do not change depending on the classroom levels. There is not a linear relationship between the ages and academic successes of students.

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Intuitive Development of the Concept of Integers among Primary School Students

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Abstract

This paper investigated the intuitive development of the concept of integers among primary school students. In order to reveal if primary school students had an intuitive sense of integers, an assessment consisting of five questions was prepared and applied to a total 100 4th grade students. A variety of integer concepts were utilized in the assessment including; integer ordering, less-than greater-than relations, as well as, integer addition and subtraction. In order to analyse the assessment data a coding system was utilized. Two researchers separately coded the students' answer responses, and later met with a third researcher to resolve any differences of rater reliability. According to the findings from this research, the 4th grade students investigated did exhibit an intuitive understanding of integers. In order to build upon students understanding of integers, examples from daily life as well as cardinal and ordinal meanings of numbers should be utilized in future instruction.

Keywords: Integers, Intuitive Understanding, Cardinal Understanding, Ordinal Understanding, Children's Thinking

Introduction

Learning begins early in life and even before the beginning of a child's formal education the concepts of numbers, counting, and relations such as more/less develop naturally through their daily life experience. In other words, daily life experiences are the basis for our intuitive learning, for example, we are exposed to the intuitive concept of negative numbers through the negative temperatures listed on a thermometer, as well as, being aware of the negative number of floors in a building. Children can perceive that the temperature of -10 degrees Celsius is colder than the temperature of 10 degrees. Furthermore, understanding that owing 10 Turkish liras to the school canteen is more debt than not owing anything. Taking an elevator with their family can also allow young children to recognize the difference between the positive and negative numbers of floors at a shopping mall. As a result, it is clear that people are exposed to negative numbers on a daily basis through a variety of concepts. Unfortunately, transforming intuitive understanding from real life experiences into formal mathematical learning can be a challenge for both educators and learners.

Past research has shown that students can have difficulty with the subject of negative numbers (Altıparmak & Özdoğan, 2005; Kilpatrick, Swafford & Findell, 2001; Beswick, 2011; Whitacre, Bishop, Lamp, Philipp, Schappelle & Lewis, 2012a; Vlassis, 2008). During the learning process of negative numbers, students may encounter a number of difficulties ranging from the construction of the concept of negative numbers (Ball, 1993; Fischbein, 1987), to understanding the four operations of integers (Altun, 2008; Crowley & Dunn, 1985; Van de Walle, Karp & Williams, 2007). When the concept of negative numbers is first presented to students it may seem abstract to them, and as a result, create conflict with their prior knowledge regarding natural numbers and mathematical operations for natural numbers. In other words, certain features relating to negative numbers can conflict with the manner in which students perceive counting numbers (Linchevski & Williams, 1999). As a result, because of the conflict that students may experience with the concept of integers, they revert to memorizing basic rules instead of actually acquiring the conceptual knowledge.

In formal education at schools children acquire knowledge regarding the cardinal and ordinal nature of numbers. Developing this knowledge is important for students because understanding the cardinal principle (e.g., cardinality) is necessary when learning the set of natural numbers. Gelman and Gallistel (1986), explain the principle of cardinality as the association of a quantity of objects to the last number from the counting sequence. While according to Bishop, Lamb, Philipp, Whitacre, and Schappelle (2014), ordinality is understood as the concept of ordering which means to perceive a set of integers not by quantity but by their sequential or positional relations (e.g., -3 is greater than -4 and less than -2). Also important, is that the principles of cardinality and ordinality are developed together; otherwise, there may be a risk that numbers are only comprehended as a quantity of a group of objects which may lead to difficulties for learners to perceive a set of integers (Fischbein, 1987; Otten, 2009). For example, at first it can be difficult for learners to accept that there can be a value (e.g., number) less than zero. Many students may be confused and only consider zero as "nothingness", and as a result, struggle with grasping the concept of negative numbers. At this point the importance combining an understanding of cardinality and ordinality becomes clearer because for some students it may be difficult to discard the idea of "nothingness" of zero based solely on the cardinal relation, yet instead working backwards from zero (e.g., the starting point) with an ordinal approach can lead to an easier understanding of this concept.

When we reviewed the relevant research studies regarding the teaching of integers, it was recognized that both cardinality and ordinality are effective strategies in the teaching

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of integers. For example, when reviewing particular studies from the literature it was determined that zero and negative numbers can be understood through ordinal values by using a number line (Bescwick, 2011; Carson & Day, 1995; Hativa & Cohen, 1995). In another example, it was determined that the conceptualization of negative numbers with the cardinal value approach was understood through the use of situations and encounters from daily life (Behrend & Mohs, 2006; Goldin & Shteingold, 2001). The success of teaching integers via both the cardinal and ordinal approach has created an argument for which model is the most effective integer instruction strategy, and as a result, a multitude of studies have been carried out to research this topic. A 1989 publication from the National Council of Teachers of Mathematics (NCTM) (1989) emphasized the use of the number line teaching strategy is more effective for teaching integers in the 5th to 8th grades. Although use of a number line teaching approach has gained importance because of its emphasis in the NCTM (1989), the cardinal and ordinal principles and the models related to these principles, should be taken together when constructing conceptual learning regarding integers as well as for other sets of numbers.

Throughout the world and in Turkey the teaching of integers in schools usually begins at the middle school level. Despite the widespread acceptance of starting integer instruction during middle school, there remains a controversy of when is the appropriate time to begin teaching integers. As of 2017 though, curriculum changes in Turkey established the teaching of integers to begin in the 6th grade. Along with introducing the concept of integers at the 6th grade level, the comparison and ordering of integers, is also included in the curriculum. In addition, following the introduction of integers in the 6th grade, the topic of operations with integers is introduced at the 7th grade level (Milli Eğitim Bakanlığı (Ministry of National Education), 2017). In the past, the concept of integers was first instructed in the 6th grade as well as the addition and subtraction of integers was also instructed at this level. Again, the more complex instruction of multiplication and division of integers was understandably left for the 7th grade level of instruction and took place as part of the "Numbers and Operations" instruction (Milli Eğitim Bakanlığı, 2013). The understanding was that the complex nature of integer instruction is better left to be instructed during the latter part of secondary school.

Throughout much of the world today as well as in Turkey the teaching of integers begins at the secondary school level even though some believe that integer instruction should begin at an earlier stage of mathematics education. The argument to begin integer instruction at an earlier age is often based on the idea that young children do have an intuitive understanding of integers, and as a result, the formal teaching or at least introduction of integers should begin during primary school (Cathcart, Pothier, Vance, & Bezuk, 2003; Galbraith, 1974; Goldin & Shteingold, 2001; Hativa & Cohen, 1995; Murray, 1985; Streefland, 1996). Another publication by the National Council of Teachers of Mathematics (NCTM, 2000), stated that students as early as the 3rd to 5th grades can begin to perceive numbers smaller than zero by extending the number line and/or by using similar forms of applications and instruction. Umay and Akkuş emphasized in a workshop report related on the evaluation of Primary-Secondary School Curriculums and Course Books published in 2008, that students should meet with the concept of "negative" in primary school, and the subject of operations in integers can start at the 6th level (as cited in Işıksal-Bostan, 2009). Furthermore, past research studies regarding the concept of integers among young children have revealed that students can develop an understanding of negative numbers as well as perform addition and subtraction at a basic level in primary school.

When examining past studies regarding the concept of integers it was recognized that a variety of researchers had carried out experiments to better understand the appropriate age for introducing and/or instructing young students about this concept. For example, Wilcox (2008), carried out an experiment with his daughter who was a 1st grade student by playing a game utilizing a number line which had zero and only positive numbers but the negative numbers were not listed except for the places where the numbers should be written. Wilcox's game also included game cards with negative or positive numbers written on them, and after selecting a card each player was supposed to start at zero on the number line and then go the specified number of places up (e.g., positive numbers) or down (e.g., negative numbers) the number line. During the game when the daughter first selected a negative numbered card (e.g., the -3 card) Wilcox observed how she reacted, and through discussion with her, she seemed to become aware of the existence of negative numbers as well as how to proceed. Although, the daughter was initially hesitant on how to proceed to the left of zero, she ultimately selected the point three spaces to the left of zero and coined this position "zero cousin -3 spot". As a result, the young girl identified negative numbers as "cousins" to the positive numbers. It appears she had discovered negative numbers by first attributing ordinal value to them, which was associated with the concept of "borrowing" in later parts of the game through an understanding of cardinal value.

In another study, Bishop et al. (2014), conducted a case study involving the use of integers for addition and subtraction with a 2nd grade student, Violet, who had not previously been introduced and/or instructed regarding the concept of negative numbers. As a result of this study, it was recognized that students can develop an intuitive understanding of negative numbers before actually receiving formal instruction about them, and it was also emphasized that reasoning solely based on ordering (e.g., ordinality) can be an effective method of understanding negative numbers as well as the operation of integers. To continue, Behrend & Mohs (2006), conducted research over a two year period with 20 first graders, where the students were instructed about the concept of negative numbers as well as about addition and subtraction accompanied by problem setting and solving activities. The study began by discussing these questions; "Do the numbers ever stop?" and "Do the numbers stop if we count backwards?" which introduced the students to the concept of negative numbers. Following the students' introduction to the concept of negative numbers, then the students were asked to complete activities and problems by using negative numbers for addition and subtraction. The research results indicated that in problem solving situations, the use of discussion regarding the presented problem, can be an effective and useful approach for developing better understanding about a topic. Finally, Whitacre et al., (2012a) conducted a study with three students, each in the 1st, 3rd, and 5th grade respectively, in order to examine the perceptions of primary school students regarding the basis of their concept of integers. In their research, they addressed the abstraction contained in the concept of integers by introducing the opposing states of being happy or sad. By introducing this abstraction, the researchers observed an increase in the 1st to 5th grade students understanding of the use of both positive and negative numbers.

Purpose and Significance of the Research

The studies of integers with young children reveals that the intuitive understanding developed by students through experiences in their daily life is an effective manner of creating an understanding of the concept of integers as well as performing basic addition and subtraction operations. On the other hand, past research has also shown that the initial learning of natural numbers in primary school ultimately has a negative effect on the instruction of integers (Fischbein, 1987; Linchevski & Williams, 1999). This presents two different situations; on the one hand the instruction of negative numbers can be started in primary school by taking advantage of the intuitive understanding of students, while on the other hand the fact that the integer instruction can be taken farther in the later grades may be a better approach. The concern related to starting the instruction of integers in the earlier years of primary school is involved with students experiencing difficulties when learning about integers in later grades. Furthermore, it unfortunately appears that the educational instruction in today's primary schools has not been able to effectively create a readiness for the instruction of the concept of integers.

It is possible that during their primary school years young children can develop an intuitive understanding of numbers and integers through their encounters with the surrounding environment as well as through counting numbers. In addition, primary school children can also gain a basic concept of rational numbers through their exposure to the concept of fractions. Most often the mathematical knowledge regarding the existence of numbers less than zero (e.g., negative numbers) is not taken into consideration until the 6th grade, and as a result, during primary school education this information has been left incomplete regardless of if the children can intuitively understand the concept or not. The risk of not presenting the concept of negative numbers to primary school students is that they may ultimately develop the perception that "there is no number less than 0" and this perception can create a faulty generalization that, "the big number is not subtracted from the small number". Future misconceptions among learners can occur if their intuitive understanding of mathematical concepts is not parlayed from their primary school instruction into the more complex instruction that occurs in the higher grades of middle school. When young children do not fully grasp the concept of negative numbers due to the instruction they received during primary school they may have more difficulty grasping the concept during their later mathematical instruction. As a result, the consideration of when to introduce and fully instruct students regarding more complex mathematical concepts, such as, integers and negative numbers should be not taken lightly and instead well researched, tested, and determined through these measures. When structured research regarding this topic is carried out, not only can assessments, experiments, and observations be utilized to better understand the best approach of where and when the concept of negative numbers and integers be instructed to students, but also; academics, educators, and researchers can be more aware of how to utilize students' intuitive understanding of these concepts before providing the more complex instruction. This is important because a better and more complete understanding of students' methods of intuitive learning and understanding can provide important and useful data regarding the appropriate period for integer instruction as well as what content and information it should include.

There has been a significant amount of research conducted in Turkey regarding integers but for the most part this past research has focused mainly on the secondary school level and has done little to address these questions for education at the primary school level. As a result, this research was focused on attempting to better understand primary school students' intuitive development of the concept of integers and negative numbers. Does children's intuitive learning developed through their own experiences involve the concept of integers as well as the basic addition and subtraction skills of integers? Specifically, this research aimed at revealing 4th graders intuitive understanding of the concept of integers, as well as, determining how the research findings can contribute to the argument for introducing and instructing the concept of integers at the primary school level.

Method

This research was qualitative in nature and aimed to investigate primary school students' intuitive understanding of the concept of integers. In order to carry out this research investigation the following form of research methodology was utilized including the participants, procedure, and data analysis type described below.

Participants

This study was conducted in a primary school located in the Çankaya district of Ankara, Turkey and took place during the 2016-17 academic school year. The research was carried out with a total of 104 participant students from four differing 4th grade classrooms. In accordance with the qualitative nature of this study, non-probability sampling was effective in determining if the school, classrooms, and students were appropriate to participate in this study. Also, as Kümbetoğlu (2005) pointed out, since qualitative research seeks to examine social reality then it is important not to just gain generalizations through representative samples but instead to choose a sample from which to compile data.

An attempt was made through purposive sampling to select a typical case sample by choosing a school with participants from the middle socio-economic class rather than one from the upper and/or lower socio-economic classes. In a typical case sample, according to Büyüköztürk, Çakmak Kılıç, Akgün, Karadeniz, and Demirel (2012), the sample is formed by choosing a typical sample from among the target population based on the specific purpose and problem associated with the research. To have a typical sample for this research, a school which was considered a relatively representative sample was selected within the research city.

To begin the data collection process of this study, a total of 104 students were provided an assessment consisting of five questions, and following review of the students assessment responses a study group of 100 students was identified. Next, according to the students' responses, a group of 11 students viewed as representative of the best assessment responses, were selected for in-depth semi-structured interviews. These semi-structured interviews were conducted in order to more precisely clarify the motivation behind students' answer responses.

Procedure

As mentioned previously, in order to investigate the students' intuitive understanding relating to integers, an assessment consisting of five questions was carried out. The assessment was made up of questions relating to ordering, less than-greater than relations, as well as, basic addition and subtraction of integers.

Initially, the assessment questions were prepared by the researchers, and then experts were consulted regarding their opinions of the prepared questions, and the final version of the questions were prepared according to the experts feedback. Next, in order to evaluate the clarity of the assessment questions, the assessment was applied to a group of similar age students in order to gain their opinions regarding the language structure and contents of the questions.

The assessment utilized in this research was compiled of five questions; the first question was the addition of a negative and positive number, and the question resembled that used by Whitacre et al., (2012a), where the opposites of happy and sad were used to demonstrate the difference between positive and negative numbers. The second question involved the addition of two negative numbers by use of the borrowing framework. In these questions, first the students were provided with a question related to a situation from daily life, and then in Part A of the question the students were asked to answer by using numbers and operations. For Part B, three different operations were provided to students and they were asked which operation given was the result to the question. This is important because in the first part of the question students were expected to use their own imagination when answering, and for the second part of the question the goal was to determine if students chose the correct operation to answer the question.

The third question was the subtraction of a negative number from a positive number, and the question presented the scenario of an elevator descending and having negative numbered floors. For question three the students were asked to answer the question directly.

For the fourth question the students were presented with five different integer pairs and asked to indicate which the greater number in these pairs was. At fifth question, a visual aid was provided to the participants by way of a number line. On the number line though only the numbers +2 and +3 were listed, and as part of the question the students were asked to fill out the number line correctly (e.g., positive & negative numbers).

After the participants had completed the study, an in-depth semi-structured interview was prepared in order to better understand the students' motivation for their answers to the questions. Following the preparation of the semi-structured interview 11 students were selected to be interviewed in-depth regarding their answers.

Data Analysis

During the analysis of the collected data, a separate code was developed for each question, and two researchers coded the data separately. The coding results of the researchers were compared and the coding consistency percentage was determined to be 98%.

For the interview and coding process the interviews were first conducted, then transcribed, and finally coded separately by two researchers. The data gathered from both the assessment and interview questions were reported under these themes; "addition of integers", "subtraction of integers", "less-than, greater-than relations", and "ordering". In order to maintain the anonymity of the study participants their real names were not used in the study and instead pseudonyms were given for each student according to their gender.

Results and Discussion

The research findings from the analysis of the data collected in this study were all listed under the themes, "addition of integers", "subtraction of integers", "less-than, greater-than relations", and "ordering".

Addition of integers

The first two questions of the assessment involved the addition of integers. In the first question (question 1), the students were presented with the following question scenario.

> *"Ayşe has happy and sad thoughts every day. If Ayşe has 1 happy thought and 1 sad thought, then she feels normal that day, in other words Ayşe does not feel happy nor sad that day. If Ayşe has 2 happy thoughts and 7 sad thoughts on Monday, how does she feel on Monday?"*

The researchers presented this scenario to the students in order to investigate how they would understand opposing situations; in particular, would the students associate the opposite situations in the question with negative-positive numbers. In the second question (question 2) the researchers presented the students with a question related to the idea of borrowing in order to examine

> *"You borrowed 8 Turkish liras for lunch from a friend yesterday. Today you have borrowed 5 more Turkish liras for breakfast from the same friend."*

The borrowing scenario question was presented to students in order to investigate their ability to associate negative numbers with borrowing. The coding system utilized in the analysis of parts A and B for the first two questions (question 1 & question 2) are presented by the following codes. Also, the findings from question 1 are presented in Table 1.

> *Code 1: Correct answers achieved by using negative-positive numbers*
> *Code 2: Correct answers reached without using negative numbers*
> *Code 3: No answer or unrelated answers*

Table 1. *The findings related to question 1*

	Part A	Part B
Code 1	9	26
Code 2	60	63
Code 3	31	11

Reviewing the analysis of question 1 it was revealed that in Part A, a majority of the students (*n*= 60) answers, were related to Code 2. These students answered, "Sad for 5 times", which utilized the operation 7 - 2= 5 and as a result arrived at the correct answer through the use of positive numbers. The responses to the same question from another nine students were more closely related to Code 1 by expressing their answer as -7 + 2= -5. This group of nine students were able to express their answer by using their intuition as it related to negative numbers. This number increased to 26 in Part B of question 1 when mathematical expressions were provided to the students in order to aid them in choosing the correct operation. The 26 students from Part B stated that the operation for the question was (+2) + (-7)= - 5, but the majority of students (*n*= 63) continued to choose the operation 7 - 2= 5, and another 11 of the students chose (-7) – (-2)= -5 which was an incorrect answer and not related to the question. Reviewing the responses provided by the students it can be stated that the tendency of most students was to reach their conclusion by considering natural numbers, yet even though this was the case it was also clear that there were students who could utilize negative numbers in their solution. Importantly, it was also recognized that some students whose answer was related to Code 2 for Part A having preferred to use negative numbers had an answer related to Code 1 for Part B of the question.

One student in particular who chose Code 2 for Part A was, Ahu. In explaining her response, Ahu, created a fictional statement regarding natural numbers.

> *"Because she is sad 7 times but she is happy 2 times. So 1 happy can eliminate 1 sad. That's why I subtracted 2 from 7. So 5 sad faces remain. If you ask which one is bigger among 5 and 2, the answer is 5. So she is sad."*

The student, Ahu, further explained her answer for Part B by stating; (+2) + (-7)= - 5, and in particular when using negative numbers, "For example, plus can represent happy, and minus can be sad".

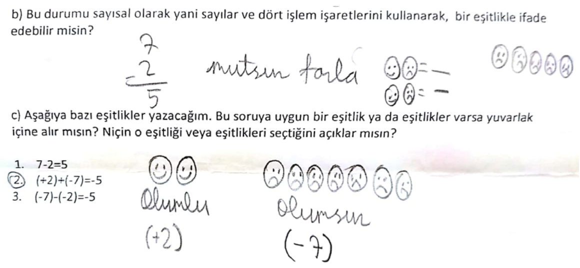

Figure 1. Ahu's answers for question 1

Another student, Engin, whose answers more closely aligned with Code 1 for both Part A and B, for example; "When she is sad for 7 times, so it goes to minus. When she is happy for 2 times, so it goes to 2 plus". The in-depth interviews conducted with students had revealed that those answers coded as Code 1 for parts A and B of the question had associated the positive and negative signs, for example, -7 and +2 with the emotions of happy and sad. In addition, as stated by one student, Ahu, it was recognized that the students who dealt with the relation of being happy and sad through the process of "elimination", complete the addition in the problem based on the cardinal values of the numbers.

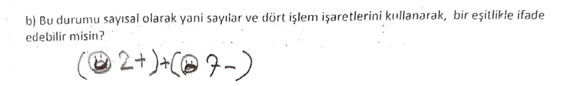

Figure 2. Engin's answer for question 1

Review of the second question (question 2) was aimed at establishing a better understanding for the researchers of any relationship that may occur between the use of borrowing and negative numbers. The findings from question 2 are presented in Table 2.

Table 2. *The findings related to question 2*

	Part A	Part B
Code 1	8	20
Code 2	82	76
Code 3	10	4

It is important to point out that for Part A of the question 2, a majority of the students (*n*= 82), provided an answer relating to the question of borrowing 13 Turkish liras by using the operation of 5 + 8= 13. On the other hand, a very small amount of the students (*n*= 8) answered Part A of question 2 more related to Code 1, for example, writing the operation as -8 + -5= -13. These responses were significant because it was clear that these students were able to associate negative numbers with the use of borrowing. As with the responses to the first question, the percentage of students who chose to write the operation for Part A of question 2 by utilizing negative numbers was quite low. For Part B of question 2, when specific mathematical expressions were provided to students, the number of students who answered the question more closely to Code 1, increased from eight to 20 students, which was similar to what occurred in the first question. The result that these 20 students provided for the problem was (-8) + (- 5)= (- 13). Importantly, when reviewing the codes for the other students answer responses, it was recognized that 76 of the students answered 8 + 5= 13 and four of them answered with 8 - (- 5)= 13. The four responses to the question which were 8 - (- 5)= 13 was actually an incorrect and irrelevant response to the problem.

Another student's responses to be discussed in detail were those of Sinan, who provided answers to both parts of question 2 in accordance with Code 1. Sinan's responses revealed that he believed the total debt could be determined when borrowing twice through the addition of two negative numbers. When the researchers inquired with Sinan why he utilized (-8) + (- 5)= (- 13) as an equation for the answer, he stated; "Because -8, I have borrowed 8 Turkish liras. In addition, plus 5 Turkish liras more I have borrowed, it means -5". When the researchers analysed all of the interviews conducted with the students, it was recognized that students whose answers for question 2 were related to Code 1, had associated the debt case to negative numbers, as well as, the addition of two negative numbers to determine the total amount of the debt.

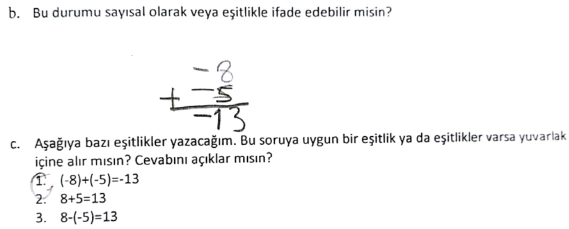

Figure 3. Sinan's answer for question 2

Subtraction of integers

In the third question (question 3) the researchers presented the students with a scenario of going down in an elevator below the ground floor and asked them to solve the question through subtraction. The question provided to the students was;

> *"5 floors of a 20 story building are underground, and 15 floors are above the ground. The entrance floor is assumed to be 0. How many floors would the elevator go down if it went to the 3rd floor underground from the 7th floor? How do you show your result through an operation?"*

Unlike the first two questions, there was no Part B for question 3 but the answers provided by the students were evaluated following the same coding system as question 1. The analysis findings from the coding of the students answers for question 3 are provided in Table 3.

Table 3. *The findings related to question 3*

	Number of students
Code 1	3
Code 2	53
Code 3	44

When the researchers reviewed the students' answers from question 3 they recognized that slightly more than half of the students (*n*= 56) provided answers which were coded as Code 1 and Code 2, and that these students reached the correct solution for the questions through various strategies (e.g., counting the floors one-by-one, completing the operation, or counting through drawing). The results revealed that only three students coded as Code 1 provided the response 7 – (-3)= 10 by using the logic of subtraction and negative numbers. In addition, just under half of the students (*n*= 44) that were coded as Code 3 provided incorrect and irrelevant answers. It appeared by the high number of incorrect responses that the students were challenged by a subtraction question, and as a result, the difficulty of the question seemed to reduce the students' level of interest in answering question 3.

Among the responses there were three students who responded correctly but could not be reached for interviewing. These three students had provided the correct solution using the numbers 7 and -3, and subtracting them in the answers but because they could not be contacted their motivation could not be investigated.

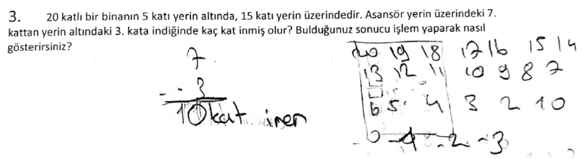

Figure 4. One of the correct answers for question 3

Less-than, greater-than relation

In the next question, question 4, the researchers provided various pairs of numbers to the students and asked them to choose the number which was greater for each pair or put an equals sign, "=", if the numbers were equal. When analysing question 4 the researchers utilized the following coding system, and the analysis results are presented in Table 4.

Code 1: The correct answer was marked
Code 2: The incorrect answer was marked
Code 3: No answer marked

Table 4. *The findings related to question 4*

Number pairs	Students' Answers		
	Code 1	Code 2	Code 3
3 and -7	85	11	4
0 and -9	85	11	4
-5 and -6	66	29	5
-100 and -5	70	24	6
-3 and -3	89	4	7

The analysis of the students' responses from question 4 revealed that when comparing positive and negative numbers or comparing 0 to negative numbers that a large majority of the students (*n*= 85) responded to the question correctly. While this ratio decreased somewhat for the questions ranking negative numbers (e.g., -5 and -6, -100 and -5) still a majority of the students, 66 in one case and 70 in another, correctly chose the greater number among two negative numbers. These findings revealed that the students had an intuitive understanding of negative numbers and could establish the relation between less-than and greater-than among integers. Furthermore, a high number of the students (*n*= 89) answered the question involving two equal negative numbers correctly.

The in-depth review of students' answers revealed that several students had a variety of motivations for providing the answer responses which they provided. For example, Deniz, correctly chose the greater number from a pair of a positive and a negative number, and according to Deniz the ordering of numbers among integers is similar to ordering the degrees of a thermometer;

"If we think of them as a degree, then negative numbers come below 0. After that, even if we pass to normal numbers, the number 3 is greater than -7."

In addition, other students provided unique answers, for example, Ahu compared 0 and -9 and correctly answered that 0 is greater than -9 stating;

"Because it is a number with minus and it is somewhere below."

Similar to Deniz, the response from Ahu revealed she preferred to establish an ordinal relationship between numbers in the vertical direction. Another student, Ezgi, responded correctly by determining which negative number of the pair was greater, -5 or -6. Ezgi did so by positioning the negative numbers relative to 0 and then determining;

"The -5 is greater because it is closer to 0. Zero is greater, too."

By providing an analogy related to an elevator going up and down, a student Emre, stated that his answer;

"Well, for example, when you put them in order, the lesser numbers are greater than the negative numbers. For example, let's think of something like an elevator in a building. Minus, a few minus goes down quite a bit."

While conducting the in-depth interview process regarding students motivations for the answers they provided, the researchers were taken by the comments from several students when they characterized positive numbers as "normal numbers", for example, Yağmur justified her characterization of the relation between less-than and greater-than numbers by expressing;

"Because -7 is already in the numbers with minus, 3 [is greater] because it is in the normal numbers" and "0 is a normal number in the same way but -9 is in the numbers with minus again".

The student, Ahu, also responded with correct answers when determining the negative number which was greater-than in the number pair, and provided a description of negative numbers as "decreasing numbers" by expressing;

"Normally, 5 is less than 6, but in these decreasing numbers, 1 and 9, -1 and -9. -1 is greater than [-9]".

The review of the interviews with the selected students revealed that among the students there was an understanding that positive numbers were "normal numbers" and that negative number were considered to be "minus or decreasing numbers".

Ordering

In the fifth question, (question 5), the researchers queried the students regarding the completion of a number line task where a number line was provided to students with spaces for both positive and negative numbers. In this task the only cues provided to students were the numbers +2 and +3 written in their places on the number line, and students were asked to complete the empty spaces on the number line including further positive numbers, zero, and the necessary negative numbers. The analysis of question 5 was completed by the researchers using the following coding system, and the analysis for the fifth question is presented in Table 5.

Code 1: The correct ordering was made
Code 2: The correct ordering was made but 0 was forgotten
Code 3: The positive numbers were correctly ordered but the negative numbers were ordered in reverse
Code 4: Only the positive numbers were ordered
Code 5: All orderings were done incorrectly

Table 5: *Findings of the question 5*

Given Answers	Code 1	Code 2	Code 3	Code 4	Code 5
Number of	53	10	14	12	11

When review of question 5 was complete it was revealed that just over half of the students, (*n*= 53), had responded to the number line task correctly and were coded as Code 1. An example of a correctly completed number line task coded as Code 1 is provided in Figure 5. In addition, when reviewing the answers an additional 10 students were able to correctly order the integers on the number line but forgot to include the number 0, and as a result, they were coded as Code 2. Another 26 of the students responded to the number line task by ordering the numbers based on the logic of positive numbers and these students were coded as either Code 3 (see Figure 6) or Code 4.

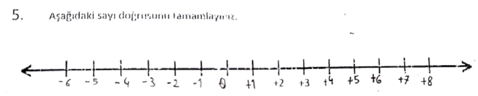

Figure 5. A Code 1 answer

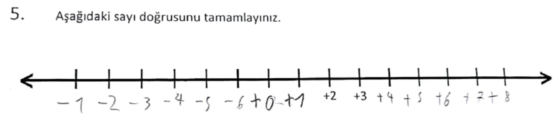

Figure 6. A Code 3 answer

When the researchers discussed the responses for question 5 with students whose answers were coded as Code 1, it was recognized that these students were conscious that they were ordering the numbers correctly and they were doing so according to smaller to bigger relationship. For example, one of the students Harun stated that they began the ordering task at + 2 and then ordered the numbers as follows;

> *"Here are the plus ones on this side, I went back +1, subtracting one number like +1 [then] 0. Then I went backwards through minus numbers."*

When the students who had responded to question 5 correctly were further queried about their answers, and in particular, if they had prior knowledge regarding their ordering choices; most stated not learning about ordering in class but instead completed the question based on the ordering they had witnessed in the thermometer and elevator scenarios. Only one student, Ahu, had stated that she had been exposed to negative numbers in school through the prize-penalty activity from kindergarten. The explanation from Ahu was that stars could be earned for good behaviour and stars could be lost for bad behaviour. This past prize-penalty activity made her realize that there must be numbers less than zero. Ahu's statements went as follows;

> *"We had such a lesson when we were in kindergarten, so if when we did bad then we got minus; it means our stars would decrease. When we did something good, our stars would increase. A friend of ours was out of stars, but after that a minus 2 was written on board. Minus 2, that is, if there were 2 more stars, she would also lose them, so I remembered it from kindergarten."*

Through Ahu's statements the researchers were able to understand that she had used the star analogy to make a cardinal relation between the positive and negative numbers, and as a result, she could transform her ideas into an ordinal number relationship when answering the test question.

Conclusion

The goal of this research was to investigate the intuitive understanding of the concept of integers among primary school students, and in particular, to gain a clearer understanding of how the students utilized their intuitive knowledge to answer specific questions related to positive and negative integers. In order to reveal if the students participating in this study had an intuitive sense of integers as well as how they utilized their intuitive knowledge to answer integer related questions, the students were assessed through a variety of integer concepts. The researchers first assessed the students regarding a variety of integer concepts including; integer ordering, less-than greater-than relations, and integer addition and subtraction. Following the assessment process, the researchers' analysis of the students' answers revealed that a majority of the students had considerable intuitive knowledge regarding the ordering and less-than, greater-than relationships of integers. For example, many of the students appeared to be aware of negative numbers, could correctly distinguish between positive and negative numbers, and also determine the greater number between a pair of disparate numbers. In addition, to better understand how students utilized their intuitive knowledge to answer the assessment questions, the researchers conducted in-depth semi-structured interviews with a small select group of students.

To begin, the in-depth interviews between the researchers and the select group of students revealed that students often made their decisions based on the concept of ordinality. This finding was important because Bofferding (2014), had also determined that young children can perceive numbers as being positional (ordinal). In addition, the assessment results revealed that a vast majority of the students were able to place negative numbers on an empty number line, as well as, establish ordering relations among integers including negative integers less than zero. These findings were also significant because similar findings had been revealed in other past studies with primary school students (Bishop et al., 2011, 2014; Hativa & Cohen, 1995; Wilcox, 2008). In the interviews with students, researchers also queried the students regarding how they ordered the integers for the number line task, and the students' responses revealed that they had utilized both the concepts of cardinality and ordinality for completing the number line task.

Another remarkable finding that was revealed by this study regarded the students' ability to carry out integer assessment addition tasks. Although a greater number of the students reached the correct answer by using positive numbers, the research findings also revealed that some students correctly answered the questions utilizing negative numbers. When considering the use of positive numbers it was recognized that in question 2, a total of 60 out of 100 students achieved their answers by way of positive numbers. These students had answered questions regarding debt by considering how much they owed through positive numbers and not by considering the use of negative numbers. This finding was also interesting because Whitacre, Bishop, Lamp, Philipp, Schappelle & Lewis' (2012b) had previously uncovered similar results in their study.

Continued review of the research analysis revealed that a small number of students, on question 1 (n= 20) and question 2 (n= 26), were able to utilize negative numbers in solving the questions, as well as, include negative numbers when completing the addition questions. Also, because of the scenarios presented to the students, it was recognized that they were able to consciously associate both positive and/or negative numbers with the idea of being happy or sad, as well as, with the idea of being in debt. For example, students had commented during the in-depth interviews that in question 1 they had added a negative number to a positive number through elimination, and for question 2 they stated associating the sum of two negative numbers with the total amount of debt. Importantly, the review of the students' responses showed that for both questions related to addition, the students had considered the cardinal values of the associated numbers. This finding was similar to Whitacre et al., (2012a), where it had been determined that children in younger age groups are in fact able to associate contrasting situations to integers.

As mentioned previously, the researchers had presented the students with scenario questions in their pursuit of better understanding the students' intuitive understanding of the concept of integers as well as negative numbers. For question 3, a subtraction question was presented through the scenario of an elevator going up and down between positive and negative floors of a building. The research findings for question 3 revealed that very few students (*n*= 3) provided a correct response by utilizing negative numbers. While on the other hand, over half of the students (*n*= 53) responded correctly to question but did so by utilizing a variety of methods. In general, the students appeared to find their solutions for question 3 by merely drawing models as well as counting the floors one-by-one.

In this study, the intuitive understanding of primary school students was investigated without the aid of an instructional experiment, and after review of the research findings it was revealed that the young students have developed an intuitive understanding of integers without prior exposure to the concept of integers from formal instruction and learning. The findings of this study are supported by several relevant studies from past research literature (Bishop et al., 2011; Bishop et al., 2014; Wilcox, 2008; Whitacre et al., 2012a). The intuitive understanding of integers that the students in this study exhibited should be considered the prior knowledge that underpins their future integer learning. The results of this research make it clear that throughout their daily lives, young children are constantly exposed to negative and positive numbers, and that these encounters are based both on the ordinal and cardinal meanings of numbers. Also, while many students understand the idea of borrowing through the cardinal value of numbers, they can also establish the relationship of ordering in integers when they are exposed to everyday items such as elevators and/or thermometers.

The findings of this research also highlight the point that while students have developed an intuitive understanding of integers during primary school, in most cases, the formal instruction of integers does not begin until the 6th grade which could be delaying young students' further understanding and learning of the concept of integers. Other important considerations are also warranted, for example, according to Fischbein (1987); Linchevski and Williams (1999), it has been recognized that the preliminary learning of natural numbers can negatively affect the learning of integers. In addition, Fischbein (1987), also attributed the difficulty experienced by students to the contradiction between the concepts, "quantity" and "magnitude", as they are related to natural numbers as well as to students attempts to transfer the usage of these concepts to negative numbers. In order to counteract these misconceptions among young students it can be argued that integers should be taught at an earlier age as an extension of positive numbers. An example of this idea was posited by Hativa and Cohen (1995), when they stated that an early introduction of students to the concept of negative numbers as well as some features related to integers can ultimately prevent students future learning difficulties associated to the concept of integers.

Considering the findings from this research study along with the findings from other past studies, it appears that the instruction of negative numbers to children before the secondary school level, should not only be carried out but in a manner that builds upon the children's intuitive understanding of these concepts. In addition, children's intuitive understanding of concepts and their ability to learn intuitively should also be supported in the students' formal education. In order to take advantage of students' intuitive learning, it is important to provide a variety of examples from daily life when teaching integers, and as a result, expose students to positive and negative numbers based on real life experiences, as well as, through the use of the concepts of cardinality and ordinality.

For future research, it is important to recognize that this study only investigated the intuitive understanding of the concept of integers and negative numbers among 4th grade students. As a result, new research studies regarding the intuitive understanding and instruction of integers to students should consider focusing on children in the earlier grades of primary school. The question of how to configure the instruction of integers before the 6th grade in effect remains unanswered, so it is suggested that this study and it findings be combined with future studies regarding the process of integer instruction for younger age children. This synthesis of research can be done in order to gain a better understanding of the relationship between students' intuitive and formal learning abilities, and in the end utilize the gathered information to develop future curriculum for young students that takes advantage of their manner of learning and understanding.

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The Language Acquisition Approaches and the Development of Literacy Skills in Children

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Abstract

The purpose of this study is to examine the language acquisition approaches whose conceptions of language acquisitions are transferred to learning environments through adjustments made on the basis of application methods. The paper also discussed their similarities and differences. Different approaches to language acquisition in various disciplines, different views, and perceptions of it have been developed. There are some approaches completely distinct from others, while there are some others affected by different perspectives. In addition to the language acquisition approaches mentioned above, the paper delineated what literacy skills are and what kind of hierarchical order is followed by the development of these skills. The study, on one hand, deliberated children's innate abilities and their acquired skills. by examining the reading and writing methods and from which approach they have been affected. The study, on the other hand, summarized the views of Vygotsky, whose contributions to learning in general and language acquisition in particular are better understood today. In brief, this paper discusses and explains the language acquisition approaches and the development process of children's literacy skills.

Keywords: Language Acquisition, Language Acquisition Approaches, Development Of Literacy Skills İn Children

Introduction

Literacy skills are of vital importance for all people and enable children to get to know the life and interact with their environment and other people, leading the way to a successful career. Starting primary school is certainly a new chapter and an exciting step for both students and their families. First-grade students attending elementary school which is the beginning of a tiring process for both teachers and students, are equipped with the speaking skill that is the most natural communication tool in a language. The hearing and speaking skills, which are essential for teaching, are two basic elements of basic language skills and they have an important role in the acquisition of two other basic skills of reading and writing. How to inculcate literacy skills in children and what methods and techniques should be applied have been tried several times for these techniques to be implemented and today new applications have been particularly implemented on the basis of learning theories. It has been observed that though conducting different methods harbour some weaknesses and strengths in comparison to others, they all lead to inculcation of literacy skills in students, whether in a short or long time, whether in a more or less meaningful way.

Reading and writing are not only two important learning domains but also two important language skills. Hence, variables such as intelligence, environment, individual differences, and readiness for learning that affect learning are also effective on the acquisition of the above-mentioned skills. Every student starts the school with his/her own learning capacity, environmental and communicative prior knowledge and level of competence and builds new knowledge on them. In this process, some students make great strides in learning while other make by slow degrees. Sometimes some children need more adult supervision and assistance than others for various reasons.

The question of "Does the acquisition of literacy skills start before children start primary school?" has led researchers working in the field to conduct a great deal of research. Some children development theorists or linguists claim that the acquisition of literacy skills is a process beginning in the womb. There are several views on the issue of the acquisition of literacy skills expressed by both the linguists arguing that language skills are innate skills and by the researchers claiming that they are acquired later in the life. In this part of the paper, the basic language acquisition approaches providing instructional perspectives in relation to how to inculcate literacy skills in children will be discussed briefly. Despite the fact that some theories have come to the fore from time to time to explain how children acquire a language skill. There are three pivot approaches to this issue dominating the literature which are the behaviourist, the linguistic, and the interactionist approaches (Maviş, 2007). The following section provides the brief descriptions of the approaches.

The Behaviourist Approach

The behaviourist approach was founded and promoted by J. B. Watson. Its philosophical ground was laid by John Locke and physiological ground was laid by I. P. Pavlov while psychological ground was laid by E. L. Thorndike, B. F. Skinner, Hull, and L. L. Bernard (Ersanlı, 2012).

The behaviourists assert that, the subject of psychology is behaviours and they can be measured and evaluated only by objective methods. In this context, no behaviour that is not objective, can be proved, objectively measured and evaluated is worth investigating. The reason why the behaviourists refused internal experiences is that they believe they could not be measured by scientific methods. These theorists who are also known as stimulus-response psychologists have primarily focused on the examination of the responses occurring in the organism as a result of the stimuli. The behaviourists who assumed and treated the human mind as the black box are interested in stimulus and response, not what is happening in the black box.

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What is controllable and measurable is what input enters to the box and what output exits from the box, it is not measurable what is happening inside the box. The study of Skinner (1957) named Verbal Behaviour, postulates the existence of human biological abilities (e.g. initial potential-speech) though he claims that there is no other language-related factor other than these. Skinner (1957) lays weight on that there is no need for any new principles of language acquisition. He believes that language is a learned skill and just a verbal behaviour. He argues that humans only use but do not own the language (Maviş, 2007).

Skinner (1957) claims that all human behaviours, including language skills, have no significant difference with compared to any other behaviour like brushing teeth that can be learned by experience. According to this approach, the language is regarded as an instrument employed in animal training by way of imitation, conditioning, and reinforcement. Hence, language is a verbal behaviour learned within the framework of conditioning. According to this definition, children's language; that is, their verbal behaviour, is a form of selectively fortified non-stereotyped vocalizations producing appropriate results in certain environments over time (Owens, 2001, Maviş, 2007)

The behaviourist approach claims that children are passive and the environment is active in language learning process. Every child comes into the world with an empty language tank and as the time progresses he/she lives with language models he/she sees around, he/she fills this tabula rasa through the experiences and the child becomes a user of the language (Maviş, 2007; Greene & Petty, 1975).

Children start to use the phonemes they are exposed to the surroundings by imitating them. Sounds and syllables that are not repeated and used or not adequately reinforced tend to get lost over time. In the behaviourist approach, they fade away. Words made up of sounds that are reinforced and frequently repeated with the help of parents or adults around are added to the vocabulary of the child; on the contrary, those which are not reinforced or repeated tend to disappear. In brief, the words that are modelled through conditioned stimuli are learned by the child (Maviş, 2007).

Although there are many criticisms on the behaviourist theories, predominantly levelled by linguistic approaches, the idea that the language is learned in the environment in which the child was born has then affected many scientists advocating socio-cultural view of language like Vygotsky (1962). The adaptation of the behaviourist approach to teaching of reading and writing has occurred in the form of children's voicing the written units they have seen under the guidance of the teacher and disintegrating the sentence into its units (words/syllables) to make sense of it. This method called "Tag Method" was employed as a way in the initial teaching of reading and writing in Turkey until recently and many adults in today learned reading and writing through this method.

The Linguistic Approach

The behaviourists' argument projecting that language is not an innate but a learned phenomenon was opposed by researchers having the linguistic view of language also known as the innatist levelling serious criticisms against it.
N. Chomsky, one of the linguistic theorists whose ideas have been widely adopted, and many other linguist scientists adopted the opinion that language is a human-specific fact and cannot be learned by other creatures. Language is claimed to be a biological-based phenomenon for humans and humans are regarded to have an innate readiness and competence to learn language. Chomsky (1967) defines this process as Language Acquisition Device (LAD) which is also called "the black box" in the literature (Maviş, 2007, Plante & Beeson, 1999). According to this approach, the child's words are passed through a neural structure called the language mechanism and the child, who is constantly exposed to the same process with the effect of the environment, will gain grammatical competence as a result. Children bring out their potential on biological language through trial and error learning. In other words, by taking the structures they are exposed to from their parents and environment as an example, they create structures from simple sentences in the "subject-verb-object" order. In the context of language acquisition of children, the two structures that compose the sentences are deep and surface structures (Chomsky, 1967). The surface structure of the sentence is composed of words while the deep structure of the sentence consists of the meanings of words and sentences (Maviş, 2007; Gleitman, Osherson & Liberman, 1995).

The linguistic approach advocating the exactly opposing view of the behaviourist approach defends the idea that children have a language at birth, bring out their potentials over time and form their language skills in a process. Since they overlooked the cognitive, social, and environmental factors they have been widely criticized. In a similar manner, this approach has been most severely criticized as it does not focus on the meaning rather on the sentence structure. This view, which does not have any aspect that can influence initial reading and writing processes or cannot add anything to instructional attempts, has mostly focused on the subjects of the adult language.

The Interactionist Approaches

The interactionist approaches comprise Developmental Cognitive Theory associated with Piaget (1971), Information Processing Theory, and Competitive Model. In addition, many other models and views along with the socio-cultural view of Vygotsky (1978b), have an important place in language acquisition. Here, mostly the ideas of Piaget (1926) and Vygotsky (1962) have been promoted as they have instructional applications for the inculcation of initial reading and writing skills in children.

The aforementioned linguistic and behaviourist views put forward opposite ideas in language acquisition., Even though they are opposed to each other, they both have strengths and weaknesses. They also put forward views that have been adopted as instructional methods in language learning. According to Maviş (2007), as implied by its name, interactionists have followed a conciliatory path by emphasizing the common and strong sides and suggestions of both behaviourists and linguists. The interactionists argue that several factors such as social, linguistic, biological, and cognitive elements affect the development process and they influence and foster each other. Cognitive and social factors improve language acquisition, in turn, language acquisition improves social and cognitive skills.

Developmental Cognitive Theory

J. Piaget is the most well-known interactionist creating the Developmental Cognitive Theory. Piaget (1971) defines the period from birth up to 18th month as the period in which a sensory-motor intelligence develops while explaining the children's mental stages of development. According to Piaget (1926), this phase is assumed to be a pre-language stage, since children in this period cannot use symbols representing objects around them. In this period, children try to understand directly objects with their senses (sensory) and their (motor) activities based on these senses. Children may not be able to distinguish objects from their practises apart from the ones they experienced (Maviş, 2007). Given the fact that even they cannot see the objects, they can still be present, not lost, children start to use symbols that represent them. Hence, these symbols become the first words they use. This process of representation constitutes the beginning of the language development (Atkinson et al., 2010). Piaget (1973), on the other hand, emphasizes that language and thought are closely related to each other. Language means cognition. Thinking is the most important tool of learning for humans. Each individual comes to the world equipped with abilities to form schemes, internalize, adapt, organize, and reconcile. Cognition relies on thinking, learning, and recall processes. Cognitive development occurs through experiences, social transitions, maturation, and balancing over time.

Vygotsky's Socio-cultural Approach

L. Vygotsky is a scientist with Socialist Marxist thought and tries to apply his views to the field of language and development. He has psychology, philosophy, literature, and law degrees. According to Vygotsky (1987), the social environment is a concept that facilitates child development and learning (Tudge & Scrimsher, 2003).

Vygotsky (1978a) believes that children gain various concepts, ideas, attitudes, and facts through the influences of the social environment. The social environment in which a child is born and where he/she lives is effective in determining the nature and the type of interaction and communication that he/she will establish. Vygotsky (1962) claims that tools such as language, number, and art are the tools of the culture for understanding, regulating, and transmitting the thought. Vygotsky (1962, 1998) claims that children are basically capable of thinking and speaking. In his context, these capacities have become integrated into the internal conversation in children at around two years of age and this internal conversation is regarded as the child's private speech (Vygotsky, 1962, 1998). This process is the child's process of internalizing thoughts, knowledge, ideas and now the child tends to think rather than voice.

Vygotsky (1978) advocates that the nature of learning emerges as a natural consequence of the effective interaction and social communication with the environment. Adults and teachers, as the role models for children, speak with them, answer their inquiries and questions and provide the necessary learning assistance they need.

Activities carried out together with the children and assistance and support provided in this process allow them to solve the small problems that they could not solve initially which is his called the Zone of Proximal Development (ZPD). The ZPD is defined as "the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under an adult guidance or in collaboration with more capable peers" (Vygotsky, 1978b). The ZPD represents the volume of learning that a student can achieve when appropriate educational conditions and support are provided (Puntambekar & Hübscher, 2005). In the ZPD concept, a teacher and a student (an adult and a child or a master and an apprentice) work together on a problem that the student cannot solve on his own or on a task that the student cannot complete on his/her own due to the degree of difficulty. Bruner (1984) asserts that the ZPD is an activity of Marxist thought requiring the more talented or more knowledgeable ones to share their knowledge and abilities with those less talented or less knowledgeable to accomplish a task. As seen from the perspective of attaining literacy skills, it is clear that assistance provided by teachers, specialized peers, conscious and knowledgeable adults for children in this process will lead to some significant instructional gains in the ZPD. The concept of decreasing and ending the assistance and support in the ZPD over time and in quantity is often confused with the concept of scaffolding, which is highlighted by the participatory modelling technique of Bandura (1977). These two concepts are combined by Wood, Bruner, and Ross (1976). supporting his/her cognitive processes In the ZPD, support or assistance provided by a teacher or an adult means speaking with students, asking questions, and giving them guidance (Vygotsky, 1987). This support students' cognitive processes (Wood, Bruner & Ross, 1976).

As a consequence, since students become more specialized, cognitive support is reduced so that they take the responsibility on their own, that is, the teacher creates a ZPD and scaffolding for students so that they can be successful here.

The cognitive support provided for children in terms of the process of acquiring literacy skills and the area of the ZPD to be established are especially important for students having difficulty in acquiring these skills. Since teaching one to one is a challenging issue and time-consuming, especially in overcrowded classrooms, it is required to devote more time to ease the process. The importance of, creating a cooperative learning environment for students with different skill levels emphasised here is consistent with the Vygotsky's cooperative learning approach.

Vygotsky (1978b) thinks that all higher order cognitive skills are shaped by the social environment. Language is the one important element that affects it. As a result, Vygotsky (1978b) emphasizes the importance of social interaction in both explaining the basic concepts of learning and communicating his views on the language acquisition. He states that the language is one of the most important means of human development and cultural transmission. In Vygotsky's (1962) context, language develops from social conversations to private conversations and internal conversations. Scaffolding for children development improves their ability to make more individual activities on their own and empowers their cognitive developments.

Vygotsky died at a very young age with a great deal of scientific research; however for a long time his studies were not recognized and published in the West. His criticisms levelled against Piaget's thoughts were popularized later and his own thoughts were overshadowed. Here what is emphasized more is instructional practices rather than creating a conception of a comprehensive theoretical context such as learning is a cultural-historical transfer. One of the main instructional viewpoints he left behind is students-teacher interaction.

Development of Children's Literacy Skills

Literacy skills are important language skills affecting the development of humanity. In general, language skills are primary mental gains that distinguish human beings from other creatures. One of the most discussed issues in the education literature is language development.

The answer to the following questions of "how does the child learn in general" and "how does the child learn reading and writing as a learning area in particular" has been sought on the basis of the body of scientific knowledge accumulated from past to present. The difference between present and past can be defined as novelties and developments in correspondence with the age. It is known that many factors such as the potential for language abilities of the child formed before the birth in the mother's womb, their interactions with the environment, the impact of mental and developmental progress, and general learning efforts are effective in acquiring literacy skills. The following questions of ‘when children are ready to acquire their literacy skills’, ‘how these skills should be acquired’, ‘how reading and writing acquisition processes progress’ have always been asked and have been attempted to be answered in the light of various opinions, approaches, and theories. The acquisition process of literacy skills is explained below.

The answer to the question of “When are children ready to learn how to read and write?” has been tried to be provided not on the basis of age but on the basis of adequacy of the norms and conditions and usually answered as when the children attain the required physical and mental maturity and level of readiness. The belief imposing that this formal education should be initiated when children are ready for the school has been accepted to be a basic principle, leading to the creation of learning tools (Teale, 1995). School age is widely accepted as 6 years of age, although it varies by culture.

There are various opinions and approaches proposed to explain the language development process experienced by the children from birth to school age, that is, in their early childhood period, before they acquire formal reading and writing skills. The process of acquiring the language skills that the behaviourist approach tries to explain with stimulus-response process ignoring mental phenomena has evolved into a structure that emphasizes the importance of mental impact, especially with the increase of psychological and brain research. Cognitive and socio-cultural views emphasizing the importance of social environment and communication have gained importance. According to this view and his representative Vygotsky, a child learns the language through the meaningful interactions he/she establishes with his/her environment and with the help of the people around his/her.

Emergent Literacy

The interaction between a child and the environment starts in the family cycle. Researchers have investigated the effect of this interaction on the acquisition of language skills and they have emphasized that the process of language acquisition should be seen as a process starting at birth and that the child learns literacy skills through the interactions he/she establish with his/her environment (Bruner, 1978; Goodman, 1984).

Ege (2007) believes, Van Kleeck and Schule (1987) described this situation as literacy socialization by classifying in three headings which are literacy artifacts, literacy events, and information gained from literacy experiences by children.

Literacy artifacts: In the surroundings of children there are many literacy artifacts such as texts on pillboxes, food packages, newspapers, magazines, books, pictures, and crayons encouraging them to write and scratch papers. Children’s interactions with these artifacts bring about various effects on children related to reading and writing.

Literacy events: Literacy events refer to the literacy activities including children’s witnessing the literacy events performed by adults and sometimes their involvement in the events. The most important literacy event for children is a reading activity performed by an adult. In this way, children can understand many things ranging from the direction of reading to comprehending the relationship between writing and verbal language.

Information gained from literacy experiences by children: Children growing in a rich environment in written materials start to learn the features of written language at early ages (Van Kleeck & Schule, 1987).

The children equipped with the early literacy skills through communication or other ways can start elementary education where formal literacy training is accessible. The skills they have acquired in the pre-school period provide them more advantageous over other children (Hood, Conlon & Andrews, 2008). The children receiving pre-school education also acquire higher literacy readiness skills.

Basic Skills Influential on the Acquisition of Literacy

Literary skills, namely reading and writing skills, are acquired through complicated mental and physical processes. There are many factors affecting this process. The cognitive process affects the development of the language and the development in the language affects the cognitive skills. During the process of acquiring literacy; children develop themselves in various sub-areas such as phonetics, alphabetic awareness, form-syllable, vocabulary recognition, reading comprehension, and writing skills which will be detailed below

Phonemic Awareness and Auditory-Sensory Awareness Skills. Children spontaneously use several sounds in spoken language. They also use words composing these sounds without knowing and thinking of the meanings of the words. Many usages in a language are automatic for them. Their language develops more in the process of time and they start to acquire skills needed to think about the language to analyse and control its units. All these skills are called metacognitive skills. Metacognitive awareness has a significant effect on the acquisition of the literacy skills (Chaney, 1994).

Phonemic awareness is a skill that affects the acquisition of literacy skill a great deal. This skill involves the recognition of the fact that words are made up of phonemes. The locations of phonemes can change depending on the word in which they are used. The disintegration of words into their phonemes and the generation of words from the given phonemes. Children generally attain phonemic awareness until they are about six years old. The instructions given in this period should particularly emphasize phoneme-letter relationship.

Another basic competence necessary for the acquisition of literacy skill is the auditory-sensory awareness. Knowing and recognizing the letter to a phoneme heard and that letters are visually different from each other is a vital indicator for both reading and writing skills. For instance, it is important to visually distinguish the letters b and d, s, and ş. Activities conducted for children to acquire these skills are the main preparatory activities for the literacy teaching (Ege, 2007).

Alphabetic Awareness. Alphabetic awareness refers to the recognition of the letters in the written language corresponding to the sounds in the spoken language. Children discovering the letter-phoneme correspondence know that letters in writing represent phonemes and they start to disintegrate phonemes, re-unite, and replace them (Ehri 2005; Stanovich, 2000). Alphabetic language systems can be formed as overlapping-transparent or non-overlapping-non-transparent. This can be accepted as a source of difficulty or easiness in learning to read and write. Given the fact that Turkish is a language in which letters are written as they are pronounced, phoneme transparently represent the letters. Hence it is safe to say that it is easier to learn Turkish than learning the languages with non-transparent alphabetic systems.

Form-syllable and Word Awareness. Form-syllable awareness is an important skill like phonemic awareness for the development of literacy skills. Syllable awareness involves the recognition of phoneme and morpheme that are the smallest units of meaning. Form-syllable awareness involves disintegrating words into syllables and meaningful parts to understand and write the words (Crystal, 1997).

Word Awareness. Words are the most essential structures in a language. Understanding of words in the spoken language is auditory while visual in the written language though a mental dictionary is used to make both of them sense. Recognition of a word is an important higher order linguistic skill to read a word. Children generally read the word by recognizing it entirely. For children, reading on the basis of the analysis of phonemes is a longer and more exhausting process.

Reading Comprehension. It is not enough to have mastered the awareness of voice, syllable, and word in order to acquire all the reading skill. Reading is an action of a completed meaning. Most of the time the reading action is performed to gain knowledge and to make an inference. As a consequence of this fact, it is safe to say that there is no way to complete the act of reading with no comprehension. In addition to the competence mastery of other higher order language skills, reading comprehension also requires affective, cognitive, and metacognitive skills such as motivation, purpose, strategies, and ability to use a strategy.

Writing Skill. Writing skill includes two main sub-skills. Kinaesthetically producing and copying phoneme-letters in a language on a writing tool is the first sub-skill while producing ideas in an organized manner by capitalizing on the possibilities of the written language is the other one.

The formal writing process involves the physical aspects of writing, such as pencil holding, doodling, line studies, direction tracking, creating letters correctly, and leaving appropriate spaces between letters and words. It also comprises the pre-skills acquired before attending the school.

Producing ideas involves an interactive endeavour leading to sharing of emotions, opinions, and knowledge, which is the main objective of writing skill. In writing for the production of ideas, skills such as prior knowledge of students, vocabulary, general command of language, genre knowledge, knowledge of idea organization, and information presentation are required. In the first grade of the primary school, first formal writing skills and then the skills of creating small texts are imparted to students. As the grade level increases, writing activities should be done in such a way as to contain ideas that require longer concentration and higher comprehension. Students should learn the writing development process. It is a worth-emphasising point that writing is a planned activity requiring both thinking and attention.

Conclusion

The ways in which reading and writing skills are acquired by children have been examined by educational scientists, psychologists, behavioural scientists, and linguists in different manners. There are plentiful discussions on the matter in the literature. Some argue that language is an acquired behaviour (Skinner, 1957), while some maintain that it is an innate skill and an inborn potential in each child that emerges later on (Chomsky, 1957). Some researchers, on the other hand, emphasize the common points of these two views, stressing that both biological elements, learning, and environmental impacts are influential on the language acquisition (Vygotsky, 1962; 1998).

Some of these opinions are adapted to educational environments from an educational point of view, and reading and writing teaching methods and some in-class activities are shaped in line with these opinions. After the 1980s, the influence of the behaviourist views and methods in literacy education have dwindled and they have been replaced by the cognitive and socio-cultural views. Regardless of whether phonics based sentence method or the sentence method is used, the child acquires literacy skills in any case; yet, newer approaches providing more meaningful learning experiences have always been preferred.

Turkey schools used to adopt the sentence analysis (tag) method as the initial literacy teaching instrument under the influence of the behaviourist approach. In early 2000s, the phonics based sentence method was started to adopt under the influence of the constructivist approach. Cursive handwriting was preferred in the writing instruction. As a consequence of the pressure imposed by teachers and parents, cursive writing gave place to print letters and all schools have taken cursive handwriting out of their teaching method. Thus, print letters have been used for few years in writing instruction.

Literacy skills are not just about reading and writing skills. Language is entirely connected with all skill areas and an instructional program cannot be organized without speaking and listening skills. The concept of literacy was originally proposed to emphasize that children have a different process of reading acquisition than adults. In the period of literacy development in children, phoneme, syllable, alphabetical knowledge, and word awareness are important higher language acquisition skills.

As a conclusion, the process of language acquisition in children evolves under the influence of several factors such as maturation, mental and physical development, linguistic development, prior learning experiences, an environment with an enhanced literacy awareness, experiences lived in the stage of the acquisition of basic skills, and social and cognitive support provided by teachers and adults for children in this process.

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