Special Issue: The Use of ICT in Education

Special Issue Editors

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Editorial

Dear IEJEE Readers,

The use of digital media, information and communication technologies (ICsT) and other technical tools became a natural part of the new generation of children and youth. We are experiencing rapid advances in ICT. The opportunities and challenges ICTs create for learning in the schools and out of school time are among the contemporary topics of interest for researchers.

In this special issue of International Electronic Journal of Elementary Education (IEJEE) many active researchers in their field addressing several issues. They conceptualize new phenomena and processes that the children and youth are involved in their daily life. They addresses their creativity, motivation, collaboration, problem-solving and literacy development while they are involved in media production and utilization.

The papers enrich our media and new technology-related conceptual world. Soloborative learning, solo thinking, collaborative tinkering, asymmetric learning, multi-user virtual environments, computer and information literacy and digital age are some of the examples for emerging concepts in the literature.

The use of ICTs does not exist in vacuum. The purpose, extend and the consequences of its use in different socio-economical contexts are topics of utmost importance for educational research. In this special issue of IEJEE the following aspects of these issues are directly and indirectly addressed with regard to a) home computer use in early years on children's social and behavioral development, b) the effect of Whatsapp usage on the attitudes of students toward English self-efficacy and English courses in foreign language education outside the school ,and c) relationship between mathematics and science literacy and ITC-variables, and d) how to measure the students' interest and enjoyment in using Information and Communication Technologies (ICTs).

I am sure that, in addition the above mentioned topics addressing digital media and ICTs, the readers will find the detailed account for digital, collaborative text-book authoring to address educational disadvantage and resource shortage in South African Schools very informative.

There is no doubt that the field of ICTs in education is broad and the topics and challenges are too many to covered depth in one special issue. Nevertheless, I hope that the readers will find the concepts, findings, experiences and arguments presented in this special issue of IEJEE valuable.

I want to express my thanks to all the contributors and to Dr. Hobbs and Dr. Özdemir additionally for their encouraging attitudes to devoting a special issue for this topic.

I also want to express my deepest gratitude Dr. Göhkan Özsoy, Dr. Hayriye Gül Kuruyer, Dr. Turan Temur for their executive editorial works and coordination.

Editor-In-Chief

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

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Transgression as Creative Freedom and Creative Control in the Media Production Classroom

Renee Hobbs*

Abstract

When students have the freedom to use digital media to create, communicate and disseminate messages, transgression occurs. In this paper, I situate in-school youth production in the context of pedagogical theories of participatory culture, art education, and digital and media literacy education. Using interviews with four experienced high school media production educators, I examine how educators perceive school situations where behavior or student media work products disrupt or transgress expectations. Teachers experience student transgression as an essential dimension of the dialectic between creative freedom and creative control. They perceive creative control to be a negotiation between students and teachers on issues of content, format, production and distribution processes. Teachers conceptualize the distinctions between students who use transgression as a form expressive creativity, a reproduction of the tropes of mass media and popular culture, the result of novices making mistakes as part of learning, an attempt to gain social power and status among their peers, or a challenge to adult authority. Teacher reflection on creative control and creative freedom may inform the design of media production learning experiences.

Keywords: Adolescence, Media Education, High School, Teachers, Video Production, Transgression, Media Literacy, Digital Literacy, Curriculum and Instruction

Introduction

Media, writing and art teachers ask students to reveal their hearts and minds, and in doing so, students may pay homage to their favorite movies or TV shows, mimicking YouTube celebrities like Pewdiepie or other aspects of the absurd adult world around them. Some teachers may wonder how to distinguish between imitation and more genuine self-expression. Because media culture includes a variety of forms of transgression, including political transgression, taboo topics and blurred boundaries, young people are also likely to reproduce and enact behaviors that may make their teachers very uncomfortable (Buckingham, 2002). For example, impromptu performance play in front of the camera may lead to clowning, mock fighting, enacting gender or racial stereotypes, and other forms of transgression, including potentially dangerous behavior, like making chemical explosions, filming from rooftops or using prop guns (Buckingham & Sefton Green, 1994).

Educators who enable student creative expression navigate complex issues of both creative control and creative freedom. This research explores complex situations when educators encounter student voices that express reprehensible values or draw lines related to social values as they decide whether (or how much) tolerance for political incorrectness is appropriate. As laptops, cell phones and free or inexpensive digital tools make it easier and easier for all students to bring their voices into the classroom, creating media is becoming more and more a part of everyday school life.

In this paper, I situate in-school youth media transgression in the context of pedagogical theories of participatory culture, art education, and digital and media literacy education. Using case studies and interviews with four experienced high school educators whose students create media in the classroom, I examine forms that transgression takes in the context of school-based media production, examining how educators perceive situations where student behavior or student work products are transgressive. I examine how

teachers conceptualize the types of transgressive student behavior they may experience. Some students transgress when they offer an intentionally critical perspective on contemporary culture and others may use transgression as a form of cheap thrills, distraction, self-entertainment or as an attempt to gain social power and status among their peers. From this study of experienced educational practitioners, this paper reveals insights on how media educators address issues of creative freedom and creative control in responding to the kinds of transgression they encounter when students make media in school. As the rise of mobile media brings opportunities for media production learning experiences to all learners, and not just those students enrolled in video production classes, this study offers insights on the design of media production activities and the spirit of reflection and metacognition needed for educators in negotiating power relationships in the classroom.

Literature Review

A growing literature in digital media and learning situates student media production as a powerful pedagogy that motivates and engages learners while developing key competencies in literacy, collaboration, problem-solving and creativity (Bennett, 2008; Buckingham, 2013; Buckingham & Willett, 2013; Ito et al, 2007) There are several ways this work has been conceptualized in the literature through the paradigms of connected learning, youth media and media literacy education. Focusing on young people's out-of-school and largely informal play and engagement with digital media, Ito et al (2013) celebrates interest-driven learning. As students participate in digital learning ecosystems, they learn by hanging out, messing around, and geeking out with digital media. In dozens of case studies about teens using digital media in and out of school, however, very few examples of transgressive youth media production are found. Indeed, student creative work reported on in the many ethnographic case studies funded by the MacArthur Foundation– including Harry Potter fan fiction communities, learning to code, and video production in and out of school -- seems quite virtuous (Jenkins et al,

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2007; Ito et al, 2009a). Students are positioned as self-directed, independent learners who, with appropriate guidance and support from mentors, create media as a natural part of the learning process (Ito et al, 2013). But other researchers have problematized youth media production and identified a variety of motives that may contribute to transgression in youth media. Studies of participatory culture do include "thick description" of transgressive incidents, but the overall focus is on the positive outcomes and involvements of the media work, as if the transgressions were exceptions or "hazards" that "go with territory" rather than a near inevitability borne of developmental and discursive power struggles.

Transgression as the Reproduction of Media and Popular Culture

Because children and young people grow up in a world where transgression is plentiful in popular culture, it may seem rather normal to create videos that depict humiliation, conflict, shame and pain through representing physical or symbolic violence, including the use of racial, gender or ethnic stereotypes or "othering." Because media culture includes a variety of forms of transgression, including political transgression, taboo topics and blurred boundaries, young people may to reproduce and enact behaviors that may make their teachers very uncomfortable. When engaged in media production activities, students may pose as fighters or display their bodies in sexually stereotyped ways. They may stage chase or fight scenes or develop narrative plots that include potentially dangerous action. They may use parody to make fun of teachers, parents and other authorities.

When students create parodies of media and popular culture, researchers have found that high school students may mock both the cultural products they see in the mass media and the realities and paradoxes of school life (Buckingham & Sefton-Green, 1994). Inversions of gender and power can be seen as particularly transgressive in the context of school. In particular, researchers describe media production activities as sites where students push up against the boundaries of acceptable school behavior. In one class, a group of girls created a mock magazine they called Slutmopolitan, which parodied the magazine Cosmopolitan. In describing the project, one of the girls identified a "tart" as, where "the lipstick is the cheapest thing going, apart from herself that is" (pp. 196-197). They even included a photograph of one of the girls simulating oral sex with a chocolate bar, with text that read, "30% extra. Only the biggest will do" (p. 198).

Clearly, pleasure and power intersect as people interact with media and popular culture. In one British school, students developed a parody for a horror film trailer involving a serial killer, in which a 16-year-old girl located the killer's motivation primarily in his gender, age, and ethnicity. The killer was Spanish, prejudiced against the English, and considered helpless elderly women to be expendable. Thus, the film involved a heady brew of gratuitous violence, xenophobia, ageism, and misogyny, all of which flew in the face of political correctness (Bragg, 2000). Such examples of transgressive creative media are not uncommon. Children's out-of-school play includes parody, gender play, and violence that builds upon, extends and subverts television advertising, movies, videogames, music and popular culture (Marsh, 2005).

Transgression as a Threat to Adult Power

As educators explore the use of media production in school, they may not be fully prepared for the issues of control that are activated as students engage with the content and format of the messages they create. Students are, of course, legally and ethically responsible for the media messages they create. But decisions about how much creative control to give students depends upon the instructor's pedagogy, values and their level of trust in their students (Darts, 2004; 2006). Faculty judgment about the appropriateness of the content of a student media production may leave the instructor's employment at risk. In some school districts, video productions are subject to district policies that state clearly that video in the classroom "shall be weighted against the value of the academic time it consumes," and that scenes that contain "vulgarity, indecency, nudity, and/or excessive violence are strictly prohibited in the classroom and school" (Saxton, 2007, 41).

One can hardly be surprised that adolescents create transgressive media as a way to gain social power over adults. When children and adolescents are constantly under pressure to conform to adult demands, their own culture becomes one of resistance inane, risqué, scatological, and politically incorrect (Mitchell & Reid-Walsh, 2002). Adolescence is a time of sturm and drang, when strong emotions and a desire for immediacy and direct experience contributes to increased risk-taking, including resistance to the traditional authority relationships that are always present in school.

Youth may use media production activities to comment on or challenge established power relationships between teachers, school administrators, parents or other adults. For example, iln analyzing a youth media production sponsored by a development agency in Latin American, researchers found substantial disconnect between the goals of the adult leaders of the program, who wanted to create a documentary about a water program for the community, and the participating youth, who were more interested in problematizing the politically-correct power relationships between the development agency and the local community through narrative production (Hauge, 2014). In observations of elementary students media making, Grace and Tobin (2002) observed that students played with "the boundaries of language and ideology and enjoy collective transgressive pleasures" (196) when they included scatological references, racial caricatures, hurtful language and forms of cruelty that reflect the Bahktinian carnivalesque (1984) when power relations are inverted. Grace and Tobin (1998) provide many examples of such parodies from third graders. These include short videos of children enjoying "butt jokes" singing off key, and performing silly antics. The children constructed visual stories involving disastrous school field trips with "tyrannical teachers, ridiculous rules and rebellious students" (49). The videos were later watched where "performers and audience were fused in a surge of camaraderie, a spirit of oneness joined by laugher" (42). Similarly, Burn and Durran (2006) observed students video editing who laced their dialogue with social chat and outrageous humor, including the witty dismissal of pretension among teachers. Hoeschman and Poyntz (2013) note that media literacy educators must be sensitive to the affective dimensions of youth media production while being careful not to excuse the "morally and ideologically objectionable practices" that can occur when students create media (135).

Nearly all of the literature on student media production and transgression has come from anecdotes reported in case studies. Interviews with media production teachers have not yet been used to gather insight on teacher perceptions of the various forms of "inappropriateness" in video production classes in elementary and secondary education. Sometimes inappropriateness may stimulate and inspire student creativity and collaboration and other times it may be disruptive, hurtful, mean and even dangerous. How do media teachers make sense of transgression when it occurs?

Methods and Context

In this exploratory study, four high school teachers, all of whom teach media production, were asked to respond to questions to better understand their definitions of "inappropriate" behavior and media content in the context of their classrooms where student media productions are being created. Adopting a perspective of critical realism (Bhaskar, 1997/1975) I assume the existence of a world that is independent of other people's perceptions but I recognize that their worlds are accessible only through subjectivity. As Edwards and Holland (2013, 22) point out, "even if reality and structures are not fully available to people, researchers can still grasp them by working from interviewees' accounts of their understandings and experiences in dialogue with theories about what social reality is like and how it works."

Participating teachers included two men and two women who were solicited from the author's social network. They include three highly experienced teachers and one in his first year of teaching. One teacher works in a public school in a largely Caucasian, middle-class suburban community, while three teachers work in public or charter schools with racially diverse students including African-American and Latino students. Participating teachers came from different educational backgrounds including independent filmmaking, business and television and cable broadcasting. As is typical of 85% of American urban schools (Hrabowski & Sanders, 2015), the teachers in this study are white and middle-class, between the ages of 30 to 55. Pseudonyms are used to protect teacher anonymity and confidentiality.

In order to gather information about their experiences in the classroom, I also asked teachers to give examples of inappropriate behavior and explain why they believed that students engaged in inappropriate behavior or why they created media with inappropriate content. Finally, I wanted to understand how teachers respond to situations where inappropriate behavior or video content occurs. I specifically asked, "How have you handled particular situations where students engaged in inappropriate behavior or produced inappropriate video content? Can you describe a situation that you handled "well"? Can you describe a situation that you handled "poorly"?

Teachers responded to these questions in writing and in some cases, additional information was provided through responses to follow-up email queries. Because there are no constraints on location, the email interview offers some advantages as participants can be widely geographically separated and can participate in the process asynchronously. An important advantage to e-interviewing is that both the researcher and the participant have time to reflect on the responses, and as Jamie Lewis notes, "a written email response 'allows participants greater scope to think about any questions asked and, as such, often encourages more descriptive and well thought out replies' (Lewis 2006, as quoted in Edwards and Holland (2013, p. 51). However, because participants used written text, it might have led to a less spontaneous account than if other interview methods were used. In considering the sensitive nature of the topic spatial separation might also have reduced the possibility of embarrassment. Below I summarize the individual responses of the teachers, followed by an analysis and examination of three key themes.

Findings

Susanne's Perspective on Transgression

Susanne is a high school video production teacher in a suburb of a large Midwest city, working with racially diverse African-American and Caucasian students from mostly middle- and working-class students. Susanne's students produce a daily newscast as part of their coursework. Her concerns about students' inappropriate behavior centers on their freedom of movement during the production process, as students are able to move freely about the school to record their video packages. She explained that sometimes, students use video cameras as a "hall pass" to leave the room and not to complete their assigned production work: this is unacceptable behavior. Also, she notes that occasionally, students abuse their power as videographers by interrupting the flow of school life. For example, some students have entered another teacher's class to record without permission. She has also experienced inappropriate student behavior when students' interpersonal conflicts cause a delay in the production process and when students use their cell phones to play video games during class. She has had situations where students produce inappropriate content, which she defines as "anything that is seen or heard on video that is not appropriate for the target audience, the students and staff at a public high school." Cursing, gang-related gestures, and the use of explicit lyrics in songs, including those that have been "bleeped out" are examples of content she considers transgressive. Content that depicts evidence of recording in an area without permission (the gym, theater, etc.) is also a problematic for her.

Susanne is aware that when her video production students make mistakes, their errors can sometimes be visible to the whole school community. She explains:

> They are under the age of 18 and are learning. They make mistakes as they go along. Mistakes are part of the learning process. Sometimes the mistakes my students make bother other teachers, but they don't bother me. The video production classes are like fishbowls. Every teacher is able to see into the bowl when a video airs. Those teachers, however, get to close their doors and teach and the mistakes they or their students make are never visible to the rest of us.

When asked why students engage in inappropriate behavior, Susanne explains that in general, students are testing limits "because they like to see what they can get away with" and because they are immature. At this age, Susanne notes, students don't always understand that behavior choices result in consequences. There have been many times where Susanne has had to handle situations where students engaged in inappropriate behavior or included inappropriate video content. When possible, and if there isn't criminal activity involved, she tries to use situations as teachable moments and she does not resort to assistance from school administrators. Instead, she talks through and explains the choices and consequences of that student or the student group's situation.

For example in one instance, students created a segment they called, "Party Boy," which featured students acting goofy in the hallway. The piece was set to music and was clearly designed to amuse and impress their peers. Susanne told students that the video was not school-appropriate and could not air. However, the students disregarded the teacher's decision and "took it upon themselves to air the video" on a day that the teacher was out of the building. In this situation, she involved the students and the Assistant Principal where they talked about what happened. Because the students were insubordinate, they were suspended for a couple of days. Ironically, students did not seem to be negatively impacted by this action. According to the teacher, "When they came back to class, we resumed our normal classroom relationship. Seven years later, we still joke about this occurrence with each other on social media." In general, this teacher assumes that transgression is developmentally normal and that it is inherently part of the practice of video production pedagogy.

Bob's Perspective on Transgression

Bob is a high school video production teacher from an East Coast upper-middle class suburban community with largely Caucasian students. Bob handles the topic of transgression right from the start of the semester, where he engages in a conversation at the beginning of each new semester by formally setting limits. He stresses the need for respect to peers and viewers in approaching the significant responsibility of producing quality content. He emphasizes the importance of developing professional respect for all members of a creative team. He identifies examples of inappropriate behaviors and he points to the school's student handbook to discuss issues of appropriate attire and conduct. Students are discouraged from producing media that infringes copyright or "involves coarse language, drugs, violence, weapons, alcohol, or images that include inappropriate gestures."

In establishing the boundaries of acceptable and unacceptable content and student behavior, Bob serves as the executive producer role for the daily broadcast his students create. When students produce videos determined to be inappropriate, Bob grades their work using the project rubric. He explains to them what changes to the content need to be made for the video to appear on school news show and/or the website. Bob emphasized that creativity is an important skill for students to develop but that communication skills are even more important. He wrote, "This truly has been an area of challenge for myself while working with students as they work on projects and try to be creative." Daily challenges include copyright infringement, social media, time management, and student attitudes towards the media class.

Bob sees how students are motivated by the desire to impress or please their peers; he notices that sometimes these efforts can be considered humorous at times and that sometimes "students think that viewers enjoy the content." The gap between the expectations of school culture and the expectations of contemporary popular culture are not immediately evident to students, as Bob explains:

> Given they see this content and behavior on television and digital media its engrained into their culture, thus they don't consider it inappropriate. This is a challenge but generally students understand reasoning but occasionally they don't consider some of the content inappropriate. This translates into many classroom discussions as to what is considered inappropriate and to whom. I emphasize the need to respect student work and creativity as well as balancing the message translated or perceived by the viewing audience.

Notice that Bob sees that discussions about transgression as a worthwhile and meaningful learning experience. As a result, he has found that only rarely do students submit video content that is inappropriate. He explains, "I try to empower my students within our studio to make decisions within a live broadcast environment as they need to understand the responsibility they have to their school and community." With this responsibility comes accountability, however. When students make repeated mistakes, punishments are issues through a verbal warning or removal from the broadcast production for one to three days. "It is a difficult decision to make," Bob explains. However, "unfortunately some students do not understand reasoning or don't agree with decisions and decide to leave the production team."

Louise's Perspective on Transgression

Louise is a filmmaker and high school video production teacher at a public charter high school which serves largely working class and poor students including Caucasian,

African-American and Latino/a students on the East Coast of the United States. She has a broad and teacher-centric definition of "inappropriate behavior" as situations that disrupt the flow of instruction. For example, when she is demonstrating how to use editing software, she considers it inappropriate for students to engage in conversations with their peers. However, she appreciates that active learning is sometimes unruly, noting that if the class is screening a film and "students comment on the action out loud or quietly to their neighbor, this doesn't bother me." For some students, notes Louise, this is an indicator that they are engaged.

As a Causasian female teacher working with a heavily male population of African-American and Latino students, Louise feels it important to note that she has never been nor felt threatened by her students. But the number one issue is cell phone use, which is a substantial disruption to student learning. Louise asks "every single day" for students to put their cell phones away. "There are few moments when the phone is necessary to capture video, to look up stuff. Otherwise, it is non-stop continuous 'passing of notes.'"

Her students engage in audience behavior that may sometimes be considered transgressive. For example, when viewing film, her students have been known to stand up and applaud certain scenes. She has had situations where, when watching a film, students have burst out expletives in frustration, loudly and with anger, a behavior that she considers to be inappropriate. However, "heavy sighs and eye-rolling" is a behavior that she sees as "age appropriate, even if it is undesirable."

Unlike the other teachers in this study, Louise allows students to create videos in a wide range of genres, including narrative forms. In reflecting on inappropriate content in student videos, Louise tolerates the depiction of everyday life in ways that resonate with student lived experience and considers herself to be rather flexible. "Maybe too much so?" she wondered, demonstrating some metacognition on her educational practice in the context of the interview experience. She permits students to include "scenes of drinking (which was simulated—or so I was told), smoking (cigarettes and simulated pot—or so I was told), profanity, fights, cutting, suicide, and murder have all been depicted in student narrative films." She has also accepted the use of profanity in student videos, noting, "When they use the word "f@*k, however, they are going for a gritty realism and I don't find this inappropriate."

Louise has accepted and encouraged student work that contradicts her own values and beliefs. For example, one student made a documentary on government conspiracies. As Louise notes, "It was pretty crazy, but she did a good job with production standards and research." During the screening of the video, Louise introduced it with the caveat that everyone has a right to their opinion and deserves our respect. She reminded students of the right to free speech. According to Louise, "This student was not very popular and quite marginalized due to her conservative beliefs and we wanted to protect her."

However, Louise has discovered some limits on the content that students produce when students refer to sexual practices. Her school administration has been involved in helping to establish them. She explains how a particular student transgression was handled:

> No one has ever tried and I have never had to censor the following content that I would find inappropriate: sexualized nudity, story or dialog that wantonly infringes on the rights of others or is otherwise insensitive to any person or groups. We did have to censor a student who, being a teenager, thought provoking the establishment (us grown-ups) with references

to blow jobs would be way cool. It was fine for his Capstone film, but my principal asked these references be removed for the final awards presentation due to children being in the audience.

Louise recognizes that some students intentionally transgress in order to provoke adults. "Without a doubt," she explains, "they do it to test boundaries. They want a reaction from the adults. In their estimation, it ups their 'cool' with their peers." On one occasion, she tried to dissuade a student from including PTSD (as suffered by a character depicted as a spy) as the focus of a humorous spoof by suggesting that might not go over well with the audience. "I let him know it was ultimately his decision," she explained.

By continuously reflecting on what works and what doesn't work, she tries to improve the class. Louise is aware that students' inappropriate behavior often comes from frustration and poor communication, noting, "We need to be mindful of what we demand from our students and how we communicate expectations." She emphasizes that film production is a creative subject, where "every assignment directly pertains to the final project (the making of a film) and is also plugged in to some part of the creative process." She teaches a bit of film history in order to support the creative process, noting that "the history of any art form provides a model of problem solving that can spark student creativity. That being said, it's sometimes a tough sell!" She values personal one-to-one engagement with students, believing that knowing each other increases the chance of positive outcomes. She tries to resist the tendency to judge students. In the end, however, Louise notes, "People are messy and unpredictable. And sometimes inappropriate." For Louise, transgression reflects students' lived experience and their depiction of it is all part of the creative process.

James's Perspective on Transgression

A filmmaker and media literacy scholar, James is in his first year teaching high school video production an alternative high school in a large city in the Mid-Atlantic region of the United States,, with predominantly African-American students from poor and working-class families. Behaviors like cursing, talking over other students, and trying to disengage from the room, pulling away to the back or the corner do occur in his classroom. But James has a high threshold for "inappropriate" behavior and tries to understand the context in which the behavior is happening. To address these issues, he uses a collaborative problem-solving model to try to work with students who have outbursts in class, seem angry or frustrated, or aren't doing their work.

Some students create media that reflects their interest in the transgressive mass media they use at home. One of James' students did a final project on the *American Horror Story* series, which features sexual violence, gore, and serial murder. In analyzing the show, the student was mostly recapping the plot lines. James tried to push her to explain why she thought the storylines were so effective in entertaining or frightening in the first place. He explained:

With a little digging, she came up with different ideas for why the material she was using seemed so 'wrong' -- for instance, she came to the idea that clowns are 'too much' -- they push beyond mere entertainment and suggest something more sinister. I think that pushing students to analyze why the media they 'imitate' might seem to be transgressive can have a lot of value, but I'm not sure if that does anything to stop the impulse that students have to imitate it, nor am I sure that such analysis should stop imitation. Imitation is a crucial part of learning, and to "learn" popular culture forms, you need to be able to imitate them.

Allowing students wide latitude in creative expression may

be part of a systematic strategy of learner engagement. Because his students have had a variety of generally negative experiences with school, James tries to give them "as much leeway as possible when making creative work." James explains:

I nudge them toward positive topics and socially beneficial ways to create fiction and non-fiction work, but I'm also pleased when they complete a project that's more "for them," including what I think a lot of educators might consider "inappropriate" -- creating songs (or using songs or videos) with cursing, glorification of drugs and violence, etc. For instance, a student might use an explicit song or video to talk about how much they like the song, without providing any particular critique of the content. Or they might create a song or rap that employs "inappropriate" material.

Many forms of student transgression result from simple imitation of the most popular forms of mass media. James believes that students don't aim to transgress when they use or imitate popular culture. Popular culture itself is transgressive, James notes, writing, "With the population of students I work with, these materials come from the everyday culture of their neighborhoods -- e.g., underground local rappers whom students may know themselves; videos and memes that are popular within their communities; etc." James sees imitation as a necessary part of learning to create digital media and it helps students to understand how media production actually works.

When video is used to depict one's lived experience, it may be transgressive, but James is sensitive to the significant gap between "personal media" and "professional media" when it comes to video creation. Comparing the gap between the personal and the professional, James redefines Masterman's (1985) "technicist trap" as a "technicist gap," acknowledging the many video production skills that separate amateur from professional production. Learning these conventions may even "distract" from more meaningful learning. As James explains:

When I've asked students to do more documentary work, I often find that even though the content of their work is more appropriate and more valued by other educators, their take-away skills don't quite get them to the kinds of production they envision from popular culture. It's like they're learning their "home" language but in a dialect they can't actually use anywhere else.

James gives students wide berth to express themselves and he tries to make the classroom a safe space to create any content within a pretty broad zone of appropriateness. He recognizes that, "in the media classroom I get a pretty raw look at the whole gamut of what I would consider wildly transgressive material." He's not yet been confronted with the production of pornography, fight videos, or other clearly off-limits material from the perspective of the school administration. He suspects that actually students are very clear about the types of material that are "absolutely off-limits." He suspects that students generally "will transgress within the accepted norms of the school or classroom."

Because James is a Caucasian teaching largely African-American youth, he is aware that his own sense of inappropriateness should have a component of "understanding where they're coming from." Because they are used to hard-and-fast rules about swearing in schools, for example, many of his students are surprised to learn that in some productions, James thinks it's acceptable for them to use curse words.

Video production can be a highly personal form of expression, enabling transgression to enter through the depiction of everyday experience. James is aware of the gap between how students conceptualize inappropriate media

content in relation to school assignments and the "more personal spaces that seep into the classroom from the periphery -- Twitter feeds with borderline-pornographic content; sexually explicit music videos; fight videos; drug use." James wishes that students would channel the energy they have for this personal media, which can often feel like a "third rail" in the classroom, into creative projects.

Discussion of transgression is most likely to occur in James' classroom when student work moves beyond the classroom to reach real audiences. Because his students are between the ages of 14 and 19, the real conversation about appropriateness happens when it comes time to distribute student work. James describes an occasion when a student who created a photo meme with inappropriate language wanted to display it on the front board of the classroom. James informed her, "Even though it was OK for her to make this image, I wouldn't display it in front of the classroom."

Discussion

Transgression in the Context of Novice Expectations

Transgression happens when beginners are socialized into a learning community. Human development scholars have also articulated the pleasures of transgression as a part of growing up. When creating videos outside of school, some researchers have found that children enjoyed transgression for its own sake. For example, in one study of children making videos at home, siblings repeatedly watched video clips they had recorded of themselves, including "transgressive moments of their gender play" as girls dressed like boys and boys dressed like girls. They enjoyed reviewing their humorous acting mistakes and bloopers. In doing so, researchers suggest that children gained awareness of how self-representations are constructed and how images function as a tool for projecting identity (Ivashkevich & Shoppell 2013). Perhaps young media makers become absorbed in the "magic circle" of creative play, which is "never imposed by physical necessity or moral duty" (Huizinga and Hull 1949, 8).

Teachers in in this study acknowledged the normality and innocence of transgression. Rather than seeing it as anathema to learning, they embrace it as a natural part of the learning process. Susanne and Louise, in particular, recognize how students experience frustration and anxiety with the novelty of the media production process and the gap between their visions for their projects and what can realistically be achieved. Recall how, in this study, Susanne noted that her students may transgress simply in order to have the freedom of movement to walk through the hall without a hall pass. Her charitable understanding of her students as young and inexperienced enables her to see transgression as relatively harmless and creates space for them to learn by making mistakes.

However, the balance between creative freedom and creative control is not always easy for teachers to navigate, and their negotiations with students does not always lead to a productive learning experience. For example, Saxton (2007) studied a high school in Utah where each student was to create a three-minute narrative film over an eight-week period. Even with lengthy pre-production instruction on visual vocabulary and technique, the project was designed to require the students to spend most of the actual production time (the actual shooting and editing of the film) outside of class, using cell phones along with Windows Movie Maker or iMovie. Although absenteeism and tardiness decreased as students developed elaborate ideas about their creative video productions, many students had unrealistic and grandiose plans for their films, seeking to incorporate weapons into their story lines,

for example. One student developed a story line with a graphic rape and murder; another developed a public service announcement that suggested that suicide could be a way to solve problems. Unfortunately, as the teacher admonished them to respect boundaries of school appropriateness, this was perceived as a "denial of freedom" that "took some of the pleasure out of the experience," as students who had to change their plans were less enthusiastic about their new ideas. During the filming process, students journals were full of frustrating venting, causing one student to write, "Screw this! I'll just take the zero!" (Saxton, 2007, 61).

Transgression as Playing to Peer Audiences

In this study, we have seen how, when students create media, they balance an interest in appealing to their peers with an interest in satisfying the expectations of the teacher. Students in Bob's class seem to have a good understanding of his academic expectations and his professional approach leads them to discuss whether a particular piece of content is "appropriate" for a particular target audience. Susanne struggled with student transgression when they aired an inappropriate video segment on the school news program even when she explicitly told them the piece was not to air: in this case, it was more important for them to impress their peers than it was to impress their teacher.

This evidence parallels a finding from a case study that reported transgressive behavior when comparing students' media production in and out of school, Tripp and Stephenson (2009) describe two working-class Latino middle-school students engaged with media at home and in a yearlong media production curriculum at school. At school, students worked on eight different media projects including creating PowerPoint presentations and digital videos. As special education students, these media production assignments offered new opportunities for them to create media as a way to learn. The students claimed these assignments were "more fun" and "better" than other types of schoolwork, but of course it was something they 'had to do,' much like other schoolwork. Researchers saw children's attempt to incorporate humor and popular culture into their work as a means to bridge the "disconnect between school media production assignments and the sense of enthusiasm students had for media culture." They describe the sheer delight of the students who, in reflecting on their work, described their use of South Park reference humor as their favorite part of the video. From their point of view, this humor was designed for their friends to enjoy. Because teachers had determined both the form and content of projects, "slipping popular culture references into projects can be seen as an effort (albeit a small one) on the part of students to make the media projects their own." The researchers note, "This small act of subverting the adult agenda and discourses involved in the project was important to some students" (Tripp & Stephenson, 2009, 1198).

As we have seen in this study, when media production occurs in school, students sometimes struggle to negotiate the interests of the peer group and the academic expectations of the assignment (Buckingham, 2003; Buckingham & Sefton-Green, 1994). Some students "walk a difficult line between 'following school rules' and 'playing to the gallery,' that is, to the peer audience" (Buckingham, 2003, 136). In one study of students in a writing class, teachers report that digital and multimedia tools for writing and composition can often inspire students to act out in the classroom in ways that express their fragile identity positions. In one case, a student called attention to herself through the media composition activities, "making exaggerated pronouncements through the activities using to elicit laughs or gasps, occasionally with sexual allusion, in-

nuendo, or other inappropriate content" (Hines, Kersulov, Rowland & Rupert, R. 2014, 487). In an interview, the student reported enjoying the expressive and performative dimensions of the project, but "resisted the turn to serious discussion reflecting on the activities." The authors point to the challenge teachers face as they work to enable productive practices with digital media, establishing a connection between the academic objectives of the assignment and issues of students' social identity.

Scholars such as Sholle and Denski (1994) spelled out this underlying bait-and -switch issue in the context of media education. In their book, *Media Education and the (Re)production of Culture*, they examined how media educators may exploit students' media interests to persuade them to use and apply academic concepts-- when what they really want to do is work and play with pop culture and their imagined media identities. As this study has shown, experienced video production teachers recognize that transgression is bound up with the reproduction and recirculation of mass media and popular culture and the inevitable tension between play and learning.

The results from this small study may make you wonder: are students more or less likely to transgress when they experience creative control or creative freedom within an assignment or class structure? Evidence from this study suggests that a context of clear expectations and norms may be associated with fewer transgressions, or at least, more mindful or purposeful or critical expressions of transgression. But it is not clear from this study whether or how transgression may support or inhibit student learning.

Table 1. *Creative Control and Creative Freedom in the Media Production Classroom*

	Creative Control	Creative Freedom
Content	Specifying the topic, issue or subject of the production	Allowing learners to select the topic, content or issue
	Specifying the use of informational content and sources	Expecting learners to freely choose informational content and source materials
	Prohibiting the use of remix copyrighted materials	Permitting the use of remix copyrighted materials
	Establishing expectations about appropriate language	Expectations about language are not explicitly presented
Format	Specifying the genre, length or medium of the production	Offering learners a choice of genre, length or medium
	Requiring elements like title and production credits	No title or credits requirements specified
Process	Setting firm deadlines for work to be completed	Learners establish their own deadlines
	Establishing expectations for individual or collaborative work	Choice to work independently or as a member of a team
	Requiring the use of particular equipment, software or technology tools	Student free choice of equipment, software and tech
Distribution	Production is expected to be viewed by an audience	Learners choose whether to share with an audience
	Target audience is determined by the teacher	Learners determine the target audience
	Teacher distributes on behalf of learner	Learner self-distributes

Creative control is the mechanism by which educators design learning experiences to meet specific outcomes or educational goals. Creative freedom is the means by which students experience true authorship. This study suggests that a balance of creative freedom and creative control may be needed in the design of video production learning experiences for high school students. As revealed in the cases, teachers may specify details of the content, format, production process and distribution of the work that students create. Table 1 depicts these four forms of creative control and freedom. Teachers may offer more or less guidance on the *content* of media productions, insisting that they be informative or academic in nature or encourage students to tell fictional or true stories. In establishing a learning *process*, teachers may set a deadline that the work must be completed within a week, but at the same time they may permit students a lot of flexibility with the *format*, giving students the ability to select the genre. They may control the *distribution* of student work, by emphasizing its publication on the school network or on the school website. Others may enable students to control the distribution of their own creative work. Through the design of learning experiences with a mix of creative freedom and creative control, video production teachers essentially negotiate with students about where, how and when transgression may occur in the context of their work.

Transgression as a Response to Creative Control

This study is this first to document how teachers themselves experience student transgression as an essential dimension of the continuum of creative freedom and creative control which is present in every learning experience. This work adds value to the voluminous literature on learners' experiences with informal production-based learning with digital media (Ito et al, 2009).

All the teachers in this study use a mix of opportunities for creative freedom and all frame up or shape learning experiences using forms of creative control. Some emphasized more professional routines of making media while others emphasized expressive and creative forms of media-making. Teachers interviewed for this study describe students who included in their video productions the lewd, the rude and the offensive simply as a part of their creative play, reflecting the freedom that is part of the creative process. Undoubtedly, transgression as a dimension of creative freedom has long been tied to innovation in culture, business and the arts. More recently, the richness in American culture has been attributed to the First Amendment's creation of unrestrained critical discourse (Batra, 2013).

Learning requires a careful balance of creative freedom and creative control in order to produce autonomy on the part of learners (Masterman, 1985). In navigating the dialectic between creative freedom and creative control, there is a key role for educators. In Lange's (2014) study of young YouTube producers, she discovered that, in creating video, young people were sometimes oblivious to the moral and ethical dimensions of their creative work. In capturing representations of subjects in front of the camera, she found many examples of young media makers depicting behaviors such as passing gas or picking noses, tantrums and physical violence. Lange describes how adolescents who created YouTube videos depicted real or dramatized altered states, following in the footsteps of the viral video, "David After Dentist" without an appreciation of the potential consequences and variety of potential interpretations that may be made. (2016, p. 167).

Sadly, some educators believe that creative freedom must be sacrificed in order to meet educational goals. Some of the teachers interviewed in this study offered substantial limits to student creative freedom with this

justification in mind. However, in the paradigm of youth media, understanding the dialectic of creative freedom and creative control may help appreciate the complex relationships that develop between youth and their digital media mentors which may occur in or out of school (Halverson, Lowenhaupt, Gibbons & Bass, 2009). For example, in Young's (2012) study of youth media organizations in Philadelphia, she analyzed how the participatory practices activated competencies that were aligned with Common Core State Standards, recognizing that youth activism is compatible with the desired outcomes of formal education.

Because media educators work closely with youth to develop ideas, it may be that a "pedagogy of collegiality" develops as teachers and learners co-produce media work in ways that transcend traditional power relationships. In *Drop that Knowledge*, Soep and Chavez (2010) describe the features of this pedagogical approach as including joint framing, youth-led inquiry, mediated intervention, and distributed accountability. But it's also possible that, in some cases, this sort of collegiality may become a pedagogy of adult hegemony, where learners get inducted into a particular (and controlling) discourse of prosocial or activist media making. Students are empowered here in the sense of occupying an identity position of greater social-political capital that does not overtly debase their primary discursive identities, but these instructional practices may still reproduce traditional power relationships of apprenticeship. To be successful, students must adopt identities preferred by the educators or artists, and though these are perhaps not like traditional educational power relationships, they are a form of creative control which imposes a critical perspective and process. Because youth media professionals spend "extraordinary amounts of time and resources to identify and develop relevant storylines for their productions," there is a common tendency for adult discourses to be reproduced in youth-produced media (Hauge 2014, 473). This may be especially ironic given that youth media productions are particularly designed to support youth voice and self-expression (Tyner, 2009).

It's worth wondering whether transgression as a form of creative expression is more or less likely to occur in contexts where student media production relies on a deep partnership between an adult educator, media artist or activist and a group of students (Goodman, 2003). Youth media instructors carefully scaffold a media production learning experience, beginning with pre-production processes to discover a message, develop a form, and usually create messages with some sort of social relevance. However, in Bach's (2010) study of a youth media organization in New York City, some resistance among youth participants was evident as they were involved in creating non-commercial public media to be broadcast to a wider audience. Although mentors wanted youth to create socially useful videos addressing political and social issues, participating youth appreciated the unrestricted communal space in youth media organizations and valued media education "primarily for its private utility – namely, the possibilities for career development and advancement it provides – rather than for its potential to contribute to a community knowledge base and serve a larger public aim" (2010, p. 1). Because youth voice itself was not critically examined, Bach found that young people occasionally created media texts that "reproduce sexist, homophobic, and other marginalizing perspectives, as youth themselves have grown up in a society wrought with these prejudices and are shaped by the institutions, social histories, and interactions they share with adults" (1).

Transgression, thus, may be the result of student awareness of the dialectic of creative freedom and creative control. For this reason, in handling learners' transgressive behavior and media content, teachers may need to show significant levels of sensitivity to both the learners and the learning context. In designing their assignments, they make flexible use of four forms of creative control to accomplish their pedagogical goals. Learners themselves can gradually develop creative control over content, format, process, and distribution.

In reviewing the literature on art education, Duncum (2007) notes that during the heyday of the creative self-expression movement, although educators emphasized the genuine freedom to explore and express as they pleased, proponents of creative self-expression were actually highly directive in their pedagogy. By the 1980s, art educators moved away from a focus on creative expression and instead emphasized Discipline Based Art Education, emphasized systematic acquisition of well-established fine arts skills and knowledge (Duncum, 2007). As a result, in many art classrooms in both public and private schools, art that connects to students' lived experience with popular culture is actively discouraged from the art classroom. For this reason, art teachers may ignore student transgression when it occurs, or fail to mention it when reporting on their teaching of popular culture. Indeed, Duncum appreciates the work of media literacy educators who have enabled students to use their interest in mass media and popular culture in ways that art educators have not.

On the ubiquitous reality of transgression in the context of youth media production, it is likely that the perspectives of experienced video production teachers may enable the framing of transgression as something to be welcomed, not feared. This approach should have value to classroom teachers across the K-12 and university contexts and may enable teachers and learners to see the negotiation of power relationships as a means for genuine co-learning opportunities to occur.

Limitations

This study also speaks to the need for youth media organizations to include a critical and reflective component to media education programs. Among the many challenges of teaching young people to produce media in an increasingly market-oriented, privatized, and commercial world is the negotiation of content, format, process and distribution issues always at play in the creative video production process.

Today, nearly every teacher can be a media production teacher, as free and low-cost video editing puts the power of video production into the hands of even the youngest children. As a result, more teachers will need to gain an understanding of transgression as matter of negotiating power. When transgression is welcomed, it provides considerable opportunities for authentic learning and personal growth. When it is feared, it inevitably reflects particular ideas about professionalization, job security and the power of social norms. When transgression is treated as a teachable moment and as a learning opportunity, it may provide instructors with insight on their own instructional strengths and weaknesses. Reflecting on how various assignments include a mix of creative freedom and creative control may help advance student understanding of concepts like format and target audience. More importantly, it may help educators and scholars revisit the social norms that exist in classrooms and how our interpersonal, institutional, and cultural expectations about classroom behavior shape, focus and direct the learning experience.

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Soloborative Learning: Solo Thinking, Collaborative Tinkering

Selçuk Özdemir*

Abstract

The history of innovation is constructed by solo thinkers and collaborative makers. The word innovation here comprises changes on technology, art and science. This article aims to reflect the way successful inventors, artists and scientists followed to do whatever they succeeded so that the coming generations can learn from predecessors' positive and negative experiences. Thinking and observing as solo may be the first step of an entrepreneur dreamer. Thinking and observation allow her to understand the size and depth of the gap on her knowledge integrity. This understanding process is a kind of challenge annoying and disturbing the entrepreneur dreamer during days and nights and causing his/her to focus on the subject including examining the existing knowledge and experiences. Successful entrepreneur dreamers are aware of the historical knowledge accumulation on the field they focus on. After an entrepreneur dreamer understands what to do, on the second step, she starts tinkering collaboratively with other people whom the dreamer needs because of their own knowledge, experiences, point of view etc. With the help of others, entrepreneur starts the attempts to fill gap on his/her knowledge. These attempts require series of trial and error. First thinking and focusing on a subject as solo and then taking action and tinkering to realize dreams and thoughts as collaborative may lead us to a new learning design approach. "Soloborative Learning" is a derivative word offering the schools a new way to design learning environments, interactions and learning materials so that learners can construct their own knowledge on an innovative and entrepreneurial ecosystem.

Keywords: Soloborative Learning, Asymmetric Learning Design, Coding for Kids

Introduction

The history of technology, art and science is full of the entrepreneurship stories including both success and failure. Succeeded or failed, all the stories triggered by an entrepreneur dreamer who is not just sitting alone lazily, but standing up to take initiative and risk with patience and determined to collaborate with others. The history of "techne" is formed of various layers constructed by different civilizations in time. From Chinese to Indian, from Ancient Greeks to Islamic Societies and finally to European Countries, during the known history of humanity, many craftsmen and artists contributed to everything we use today in our daily lives. Whatever we use as a techne today is an output of a cumulative knowledge grown out for years. For example, a dream about communication with people living on remote places caused many creative explorations started by smoke and for now ended by cellular phone. Another dream about feeding easily and safely firstly led to the use of spear and finally vertical farming. Actually, a cellular phone is the newest version of communication using smoke and vertical farming in a greenhouse is the newest version of a spear! What happened in time is just a successor who is a visionary added new knowledge and skills to the existing knowledge and skills produced by a predecessor who was a dreamer. It is impossible to find technology or scientific knowledge which is not based on a prior knowledge.

What is the behavioral pattern of a successor entrepreneur dreamer? Are there any pattern of entrepreneur dreamers on how to realize their own dreams and thoughts? When you examine the lives of noted scientists, artists, philosophers or technologists, most of their journey towards success start with childish thoughts about a problem or situation. They observe their own surroundings, then they catch some details unconsciously or consciously. Whatever they catch triggers related and more detailed observations, because the details they caught during observation instigates the

gaps and shortage on one's knowledge integrity. Livio (2018; p:71) emphasizes that this instigation causes a kind of cognitive itching. The cognitive itch feeling disturbs and pushes the person to fill the gap on his/her knowledge integrity. Thinking and observing as solo on the caught detail may be the first step of an entrepreneur dreamer, because he/she tries to understand the size and depth of the gap on his/her knowledge integrity. This understanding process is a kind of challenge annoying and disturbing the entrepreneur dreamer during days and nights and causing his/her to focus on the subject including examining the existing knowledge and experiences. Successful entrepreneur dreamers are aware of the historical knowledge accumulation on the field they focus on. After an entrepreneur dreamer understands what to do, on the second step, he/she starts tinkering collaboratively with other people whom the dreamer needs because of their own knowledge, experiences, point of view etc. With the help of others, entrepreneur starts the attempts to fill gap on his/her knowledge. These attempts require series of trial and error…., constructing and breaking down and reconstructing and breaking down. First thinking and focusing on a subject as solo and then taking action and tinkering to realize dreams and thoughts as collaborative may lead us to a new learning design approach. "Soloborative Learning" is a derivative word offering the schools a new way to design learning environments, interactions and learning materials so that learners can construct their own knowledge on an innovative and entrepreneurial ecosystem.

Asymmetric Learning Design for Soloboration

The existing school system, designed due to the needs of the Industrial Revolution, hasn't been responding to the needs of the 21st Century. The Industrial Revolution forced people to do just whatever is required of them. In the Industrial Age, Taylorism and Fordism production models divided all businesses into pieces, and required workers to just focusing on the job they were directed to. The workers were not able to

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see the whole picture of production, but they were only aware of whatever was dictated to them. The classical schooling was structured similar to industrial organizations. All the disciplines were divided into courses, and all courses divided into chapters, all chapters were divided into goals and learning outcomes. Each single course was positioned as symmetric and parallel to other courses without touching each other. All the behaviors a student should gain were defined exactly by educators. If a student showed average learning outcomes especially in multiple choice exams, he/she was considered to be successful. On the other hand, the students failed if they were unable to find the correct answer among the given choices A, B, C, D or E.
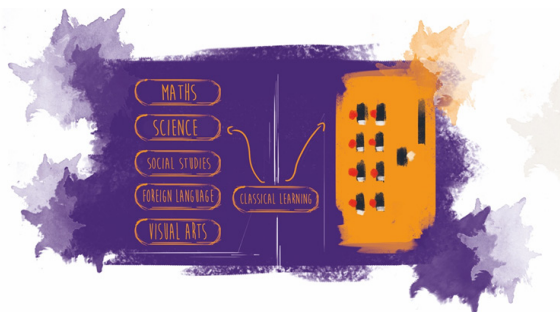

Figure 1. Classical learning

Why does classic schooling system not work to respond to the 21st Century's needs? The reason is hidden in the "changing concept of labor". The 21st century creates its own machines to do average work and to select correct answer among the given choices. The changing labor will force the new generations to find their own F choice, H choice or Z choice. In short, today's primary and secondary school students have to be innovative, creative, visionaries, entrepreneurs and collaborators to exceed average skills (Rose, 2016; Rifkin, 2011), otherwise, smart machines and software will already do whatever their parents were doing in the past.

To be more creative, innovative, collaborative and entrepreneurs, the students need to face more ill-defined problems and to find solutions using information from different disciplines such as Math, Science and Humanities etc. in the school environment. Ill-defined problems can be defined as "problem in problem" (Morin, 1999; p: 11). Edgar Morin says that in real life situations, the new solutions for problems may cause new problems and schools should teach students how to solve problems in problems. As long as you find solutions, you may face new problems caused by your solution. Moreover, solutions for problems in real life requires use of more than one discipline. When you decide to produce a new car, just mechanical engineering is not enough, you will need visual artists, masters on ergonomics, computer programmers, and many more skills and knowledge from different disciplines. The students should practice on how to use more than one discipline at the same time for the same problem situation.

Goethe says that he hates everything that only instructs him without augmenting or directly invigorating his activity (Nietzsche, 1996). Learning process should increase children's effectiveness and add values directly to their lives. To prepare students so that they can solve "problems in problem" and handle information from more than one discipline, the learning process should better start with an entrepreneurial problem, because entrepreneurial problems:

- are formed from vague and ill-defined ingredients causing problems in problems

- need various information and skills forcing students to use more than one discipline,

- need more labor and various points of view to complete the task requiring collaboration, creative thinking and critical thinking,

- require patience and persistence to solve the problems in problems.

The entrepreneurial problem can be designed by a group of teachers from different disciplines such as math, physics, chemistry, geography, language, computer sciences etc. or determined by student(s) by the help of teacher(s). The entrepreneurial problem should be complex enough to confuse the students, because human beings are not curious about the things which they know well or do not know anything about (Livio 2018; p:71).

After the presentation of entrepreneurial problem, each student starts to examine, analyze and think of the problem as solo or in small groups sharing with each other. After the causes of the problem are listed, the students should start to collaborate with other students and teachers to find out the optimum solution and to realize the offered solution. This collaboration process is asymmetric, because each offered solution may require information and skills from different disciplines. The information and skills quantities needed from different disciplines can also be different from solution to solution. While a group of students in collaboration may use 25% math, 10% physics, 50% visual arts and 15% ergonomy, another group of students focus on mostly math and physics and biology to solve the same problems. In an asymmetric learning environment, even teachers cannot guess which disciplines students will use and the weight of each discipline on the solution, because students will not select a choice among the given ones, but they will create their own choices from which the teachers may learn something new.
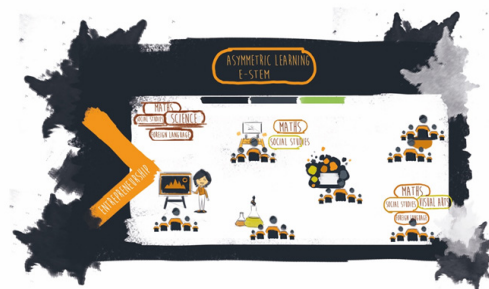
Figure 2. Asymmetric learning

The most important point for an asymmetric learning environment is that, all the disciplines are just sources and instruments for the solution of entrepreneurial problem. The learning environment designed as a workshop should facilitate the use of information, tools and skills from math, science, digital/non digital technologies, social science and humanities. During the development of a solution, students may try their thoughts many times. As long as students can use sources and instruments easily, they will be able to develop their solutions even compared to solutions they thought at the beginning of the study.

The Miracle of Ctrl+Z for Soloboration

The history of "techne" is the history of thinking and tinkering. The history of science and technology was written by the people who were patient enough to repeat the experiments many times. For thousands of years, all the entrepreneurs in the field of science, technology, politics, art

etc. have tried, failed, learnt, and tried again in their own limits of time, infrastructure and finance. They sometimes learnt from their own experiences and sometimes from others' experiences as Einstein was saying "My best teacher was Newton. Without his findings, I could not have been able to find out anything." Somehow, each new knowledge is constructed based on the existing information and experiences. Here, what I want to emphasize is that even computer software development is one of the youngest and newest fields, today it is the most important technological and scientific field even for all other technological, scientific, artistic etc. fields because of its "forgiving" aspect. Da Vinci says that "wisdom is the child of experience." Since on any other field no one has unlimited right to make mistakes, the accumulation of experiences and knowledge creation is limited compared to software development. Trial and error method on medicine, engineering, farming, any field except for software development is very expensive and risky. On the other hand, you can try any dream you have on computer programming process, because you know that when you make a mistake, just pressing "Ctrl+Z" keys is enough "to be forgiven." These keys may be the biggest reason we have crazy software on our computers, tablets, PCs, smart phones, cars etc.

Nowadays, computer coding courses for primary and secondary school students are very popular around the world. It seems that coding will be one of the very important basic skill for the coming generations. Computer coding skills may be a kind of new paper and pencil for them to articulate and create what they think. John Dewey, Maria Montessori, Ivan Pavlov, Frederic Skinner, Jean Piaget, all education philosophers having different theories on pedagogy pointed out the same aspect of learning: practice. Practice was the basic and first condition of learning even before classical schools. Today, computer coding ability is a very cheap, patient and easy practice tool for learning starting from primary schools. Similar to professional software developers, children can test and practice giving directions to machines (computers and similar devices) on whatever they think and want to do. Computer coding ability and its Ctrl+Z aspect enable students to embody their dreams and the way they think. Here, the childhood of Elon Musk, Steve Jobs and Bill Gates are important examples. Elon Musk says (Vance, 2015;) that when he learnt computer coding himself at 10, he realized that he could do anything giving directions to computers. Interestingly, his first dream was the driverless cars he presented to us today!

To conclude, as a Turkish academician and entrepreneur, 5 years ago, I developed an asymmetric learning design for primary and secondary schools and today about 100.000 students on 350 schools use this platform in 70 cities in Turkey. This new learning design Includes:

> • 15.000 online content on coding, 3D design, circuit design, entrepreneurship etc.,

> • Face to face trainings for teachers from different disciplines,

> • A modular curriculum adaptable for the needs of each school.

> • Rubrics to evaluate products and processes,

> • The digital and non-digital materials for workshops,

> • Tournaments and fairs so that students could show whatever they learnt and whatever they developed.

Rewarded three times by national institutions, this initiative aims to offer schools an alternative way of designing the 21st century learning ecosystem, because today's children will face a very different social and professional life compared to their parents'. So, forcing them to be educated in the schools designed 200 years ago may cause great social problem s when they try to find jobs starting from 2030s. So, it's time to act before it can be late to use "Ctrl+Z"

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The Effects of 3D Multi-User Virtual Environments on Collaborative Learning and Social Presence

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Abstract

Three-dimensional Multi-User Virtual Environments (MUVEs) are being increasingly used in many areas, and they are becoming more and more integrated with learning and teaching. MUVEs can be used in learning and teaching to facilitate student learning and collaboration. This study identified the effects of MUVEs on collaborative learning and social presence and investigated whether these effects varied by gender. The participants were sophomore students attending a programming language course. They used a MUVE for their group meetings as part of their collaborative work. They also held voice communication. A four-section questionnaire was administered to the students who attended the meetings, in which the researchers served as facilitators. Interviews were held with randomly selected students. In addition, the group project meetings were tape-recorded, and field notes were taken for each meeting. The results showed that the MUVE enabled the group members to exchange ideas in an authentic environment, and that the file-sharing platform used as a complement to the MUVE reinforced collaborative learning. As long as technical problems are prevented, effective collaborative learning can be achieved in these environments.

Keywords: Artificial, Augmented, Virtual Realities, Collaborative Computing, Collaborative Learning, Distance Learnings

Introduction

Rapid advances in information and communication technologies have led to an increase in the use of three-dimensional Multi-User Virtual Environments (MUVEs) in many areas (Blas, Bucciero, Mainetti, & Paolini, 2012) especially in the video game industry. In the meantime, changing students' needs and increasing use of technology in education lead educators to move on different technologies in educational area. During these developments, MUVEs are becoming more and more common in education as a new technology most specifically to create authentic learning environments (Doğan, Çınar, & Tüzün, 2018). MUVEs are seen as an important technology to facilitate learning process if it is integrated into education within a well-designed educational context (Blas et al., 2012). Especially, the academic world and educators has been quite interested in the use of MUVEs (Dickey, 2000; Doğan, Çınar, & Tüzün, 2018; Messinger et al., 2009; Poppe, Brown, Recker, Johnson, & Vanderfeesten, 2017) since their future of being effective in remote collaborative learning environments due to their immersion, interaction and communication capabilities (Ibanez, Rueda, Maroto, & Kloos, 2013). According to the 2007 Horizon Report, three-dimensional environments can potentially be used in future educational processes, and developments in open sources and standards will bring MUVEs closer and closer to formal educational methods with each passing year (EDU-CAUSE, 2007).

MUVEs are defined as persistent and dynamic simulated three-dimensional environments that are characterized by rich graphics, high-quality sound, motion, perspective, and interaction (Schultze & Orlikowski, 2010). Virtual environments are three-dimensional environments in which people can move around using avatars, interact with others, manipulate objects, and get information (Sallnas, 2005). The design of modern virtual environments has been predominantly pseudo-realistic. This is not a photorealistic design, but a de-

sign in which designers assemble components from the real world (McCreery, Schrader, Krach, & Boone, 2013). Originally introduced as video game environments, virtual worlds have received wide currency in the business world and educational settings in the form of project management, online learning, and simulations (Schultze & Orlikowski, 2010). Educational MUVEs combine two-dimensional and three-dimensional virtual worlds in which users are represented by avatars (Cobb, Neale, Crosier, & Wilson, 2002; Nelson, Ketelhut, Clarke, Bowman, & Dede, 2005). Using avatars provide users to explore three-dimensional worlds, to interact with objects, to communicate with other users, and to participate in collaborative activities. Each virtual world has its own visual theme, mechanisms, and intra-world activity groups. A common practice in most MUVEs is collaborative activities (Annetta & Park, 2006; Bruckman, 1996; Bruckman, 2000; Clarke, Dede, Ketelhut, & Nelson, 2006; Corbit, 2002; Dickey, 2000; Dickey, 2003; Nelson et al., 2005). In some studies, virtual environments defined as Collaborative Virtual Environments (CVEs) in which users can share virtual objects, communicate and work together through 3D spaces (Chellali, Milleville-Pennel, & Dumas, 2013; Poppe et al., 2017).

Social presence concerns the realism of these environments. It refers to the extent to which people are significant in their interpersonal interactions. Social presence theory is used to determine whether an environment can enable its users to feel that they are physically present in an environment. Using face-to-face communication as a standard, social presence relies not only on words, but also on non-verbal body language and content (Rice, 1992). Research on online discussion environments suggests that technological media has the ability to generate the feeling of presence (Bosch-Sijtsema & Haapamaki, 2014; Gunawardena & Zittle, 1997; Leh, 2001; Poole, 2000; Rourke, Andersın, Garrison, & Archer, 2001). Especially, virtual environments' capability of producing a sense of presence is underlined in literature (Davis, Murphy,

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Owens, Khazanchi, & Zigurs, 2009; Zhao, 2003). Avatars are seen as the most effective tool in virtual environments to provide social presence (Bosch-Sijtsema & Haapamaki, 2014; Davis et al., 2009; Zhao, 2003).

Project-based collaborative work has been used intensively in both business and education. In addition, there are more and more people who attend online distance learning programs. Therefore, studies have focused on how project groups should meet and solve problems associated with their collaborative work. The distance between users is a significant factor in this respect. In collaborative work, it is likely that physical distance between users will negatively affect productivity. Swan (2003) asserted that educational activities should be restructured in a way to reduce the psychological and emotional problems brought on by distance. This is because, as stated by Salmon (2004), collaboration is only possible when users feel at ease and are provided with the opportunity for online socialization. MUVEs have different features that provide project members to interact with avatars and enable distant team members to collaborate in project studies. Thus, sense of presence and social interaction option through MUVEs can provide a sense of shared space among the distributed team members which can affect the group performance positively (Bosch-Sijtsema & Haapamaki, 2014).

Many researchers have reported that the distinctive interactive processes of collaborative learning offer many advantages (Hämäläinen, Manninen, Järvelä, & Häkkinen, 2006). Moreover, it is important to provide sharing and developing new ideas among the distributed team members in collaborative team studies (Bosch-Sijtsema & Haapamaki, 2014). MUVEs can be alternative ways to provide communication and collaboration among team members especially in distant team members. A review of the literature indicates that there are many studies on the use of information and communication technologies for educational purposes. However, few focus on the effectiveness of the use of three-dimensional MUVEs for group projects. There is limited research on the use of MUVEs, which are developed mainly for recreational purposes, for collaborative learning (Edirisingha, Nie, Pluciennik, & Young, 2009). This study had students collaborate on a project in a three-dimensional MUVE to determine the effectiveness of the environment.

Research Question

The research question was: "What are the effects of three-dimensional Multi-User Virtual Environments on university students' collaborative learning and social presence during collaborative work on a group project?"

Methodology

This is a mixed-method study, using both quantitative and qualitative research methods. Adopting an ethnographic approach, a form of qualitative research, the researchers participated in project group work in the three-dimensional multi-user virtual learning environment and observed the procedures. Then, they held interviews with the participants. Finally, a questionnaire was administered to the participants to collect quantitative data.

Research Context and Participants

The participants were composed of sophomore students attending the course, Programming Languages II, as part of the curriculum of the Department of Computer Education and Instructional Technology at a large state university in Ankara, Turkey. Purposive sampling was used to

select 35 students to meet regularly for collaborative work on a group project.

While 33% of the participants were female, 67% were male. More than half of them (60%) were intermediate computer users, and 40% were advanced. Only 40% of the participants had experience with MUVEs, and only 3% had an experience with collaborative learning activity in such an environment.

Procedures

This study used Active Worlds, an online three-dimensional multi-user virtual environment, which was developed to host many virtual worlds. Users can move around these virtual worlds using their accounts. They are represented by customized avatars. They can use written and voice communication (through VoIP). In addition, Dropbox was used as a file sharing environment to supplement the three-dimensional multi-user virtual environment.

Before the study, the researchers held test meetings in Active Worlds, during which they tested both written and voice communication. They created usernames and passwords for the participants. They discussed which application they would use for the meetings and worked on the design of the environment. Of the researchers, one facilitator was assigned to each project group. In addition, a meeting room was created on Active Worlds for each project group. Each meeting room included photographs of the students and the facilitator, which were linked to the personal webpages designed by the participants to introduce themselves. A four-week period was scheduled for the meetings, and the plan was to have at least one meeting per week with each group. Before the meetings, the students were informed by the instructor about the process and given "Principles about the Facilitators," a document prepared by the researchers and the instructor. The document described the relationships between the students and their facilitators as well as the duties of the latter. The researchers who would serve as facilitators cooperated with the instructor to collect information about their project group. Finally, the facilitators sent e-mails to the students in their groups to introduce themselves briefly and give them their usernames and passwords.

During the study, the facilitators held group project meetings in the MUVE with the project groups. Figure 1 shows a sample screenshot of a meeting. During the meetings, the facilitators observed student activities and the usability of the environment. As facilitators, the researchers checked on the students' work once or twice a week for four weeks and took field notes after each meeting.

Figure 1. A sample screenshot of a project group meeting in active worlds

After four weeks of meetings in the MUVE, the Collaborative Learning, Social Presence and Satisfaction Questionnaire was administered to 30 students who had

participated in at least one of the meetings. In addition, semi-structured interviews were held with 12 students, three randomly selected students from each group. Depending on availability, these interviews took place either face-to-face or on the Internet. With the students' consent, the meetings were tape-recorded and transcribed.

Data Sources

The Collaborative Learning, Social Presence and Satisfaction Questionnaire, developed by So and Brush (2008), was adapted to the context of the three-dimensional MUVE. The qualitative data were collected through semi-structured interviews with questions created by the researchers. Field notes by the researchers were used as qualitative observation data.

The collaborative learning, social presence and satisfaction questionnaire

This questionnaire has four sections: demographics, collaborative learning, social presence, and satisfaction. The first section contains questions about the participants' gender and age as well as their experience with computers, MUVEs, and collaborative learning in a MUVE. The second section, which addresses collaborative learning, has 8 items, which were adapted to this research. The third section on social presence originally had 17 items. For this study, 5 items were excluded as inconsistent with the purpose of the study, resulting with 12 items. The 11 items in the last section, which attempts to measure the level of student satisfaction, were adapted and then used. The questionnaire thus had 36 items, 5 in the sub-dimension of demographics and 31 items in the sub-dimensions of collaborative learning, social presence, and satisfaction. The questionnaire uses a five-point Likert-type scale with these options: "Strongly Disagree," "Disagree," "Neutral," "Agree," and "Strongly Agree." The questionnaire was revised after consultation with two instructional technology specialists.

The semi-structured interview form

In accordance with the purpose of this study, the researchers developed a semi-structured interview form to collect information about the students' experience with the MUVE, its usability, and its contributions to communication, as well as about the effectiveness of the group projects and sharing. The form consisted of 12 questions in two sections. The first section asked questions about the MUVE, and the second section asked about the group activities during virtual meetings. The form was revised in accordance with the opinions of two instructional technology specialists.

Field notes and tape recordings

The researchers attended the meetings in the MUVE as facilitators. For each meeting, they took field notes to record their observations. Some meetings were tape-recorded in the form of streaming video. In the end, there were 28 pieces of field notes, one for each meeting.

Data Analysis

The data analysis involved the data from the questionnaire, the field notes, and the observation data. This study used triangulation, which is a widely recommended method for ensuring reliability in qualitative research (Denzin, 1970; Denzin, 1978; Patton, 1999). All three components of triangulation were used: (1) multiple data collection methods, (2) multiple researchers, and (3) multiple sources of data. This study's multiple data collection methods were observation, the field notes, and the questionnaire. The transcripts of the interviews were coded by more than one researcher, which ensured that multiple researchers were involved in data analysis.

The field notes and interviews, the study's qualitative data, were subject to content analysis and themes were generated. The analysis of the data from the questionnaire, the study's quantitative data, involved frequencies, distribution of percentages, and an independent t-test. The level of significance for statistical analysis was 0.05.

Findings

The findings are presented under three headings: data from the questionnaire, field notes and interviews.

Data from the Questionnaire

Collaborative learning

The participants reported that their experience with collaborative learning in the MUVE was not better than face-to-face collaborative learning. In addition, most were neu-

Table 1. *Collaborative Learning in the MUVE*

Collaborative Learning Dimension		Collaborative Learning in 3D MUVE								
		Strongly Disagree		Disagreee		Neutral		Agree		Strongly Agree	
		f	%	f	%	f	%	f	%	f	%
1	Collaborative learning environment in 3D MUVE is better than in a face-to-face learning environment.	14	47	10	33	3	10	3	10	0	0
2	Overall, I am satisfied with my collaborative learning experience in this course.	3	10	7	23	14	47	6	20	0	0
3	Collaborative learning in my group is effective.	2	7	14	47	8	27	6	20	0	0
4	I was able to develop problem solving skills through peer collaboration in 3D MUVE.	4	13	14	47	8	27	4	13	0	0
5	Collaborative learning in my group was time-consuming.	1	3	8	27	4	13	7	23	10	33
6	I felt part of a learning community in my group.	1	3	8	27	10	33	11	37	1	3
7	I actively engaged my ideas with group members in 3D MUVE.	3	10	10	33	5	17	11	37	1	3
8	I was able to develop new skills and knowledge from other members in my group study in 3D MUVE.	7	23	6	20	8	27	8	27	1	3

Table 2. *Social Presence in 3D MUVE*

Social Presence Dimension		Social Presence in 3D MUVE								
		Strongly Disagree		Disagreee		Neutral		Agree		Strongly Agree	
		f	%	f	%	f	%	f	%	f	%
1	Using 3D MUVE is a pleasant way to communicate with others.	5	10	4	13	6	20	10	33	5	17
2	The language people use to express themselves in online communication is stimulating.	5	17	6	20	9	30	10	33	0	0
3	It is easy to Express what I want to communicate through 3D MUVE.	6	20	7	23	5	17	9	30	3	10
4	The language used to Express oneself in online communication is easily understood.	4	13	9	30	6	20	10	33	1	3
5	I am comfortable participating, even though I am not familiar with the topics	5	17	8	27	4	13	11	37	2	7
6	3D MUVE is technically reliable.	3	10	3	10	9	30	13	43	2	7
7	3D MUVE allow relationships to be established based upon sharing and exchanging information.	4	13	4	13	10	33	12	40	0	0
8	3D MUVE allows me to build more caring social relationship with others.	6	20	11	37	5	17	7	23	1	3
9	It is unlikely that someone might obtain personal information about you from the 3D MUVE messages.	2	7	9	30	11	37	6	20	2	7
10	Where I access 3D MUVE (home, office, computer labs, public areas, etc.) does not affect my ability/desire to participate.	9	30	9	30	3	10	7	23	2	7
11	3D MUVE permits the building of trust relationships.	6	20	6	20	5	17	13	43	0	0
12	The large amounts of participants in 3D MUVE (numbers of participants and frequency of dialogs) do not inhibit my ability to communicate.	7	23	3	10	4	13	12	40	4	13

tral about their level of satisfaction with the experience. Moreover, the dissatisfied participants outnumbered those who were satisfied. Slightly less than half of the participants (47%) described their level of satisfaction as "neutral," and 33% reported their dissatisfaction. Only 20% reported that they were satisfied (Table 1). Furthermore, the participants did not agree with the idea that their problem-solving skills were developed through collaborative learning in the MUVE, nor did they think that collaborative learning in their group was effective. More than half of the participants (54%) said that the activities in the MUVE were not effective collaborative learning, and 56% reported that collaborative learning in the MUVE was time-consuming (Table 1).

Social Presence

The participants reported that using the MUVE was a pleasant way to communicate with others, and that the MUVE was technically reliable. Half of the participants said that using the MUVE was a pleasant way to communicate with others. In addition, 40% said that the MUVE allowed relationships to be established based on sharing and exchanging information. However, 57% of them disagreed with the idea that the MUVE helped them establish social bonds with their group (Table 2).

Satisfaction

It was found that the participants learned from their experiences in the MUVE, these experiences were useful, the activities assisted them in understanding other points of view, the facilitators met their expectations, and the diversity of the meetings helped them to express their opinions in the discussions. Even so, the MUVE did not fully meet their expectations or stimulate them to do additional research or activities.

Two-fifths of the participants reported that the activities in the MUVE were useful experiences. In addition, half of them said that the meetings in the MUVE helped them to express their opinions in the discussions. Nevertheless, the MUVE did not fully meet the expectations of 44% of the participants (Table 3).

The results of the questionnaire were also analyzed by gender. The questionnaire forms were filled out by 30 participants (10 female and 20 male). The mean scores of the female and male participants in collaborative learning were 20.4 and 22.5, respectively. In other words, male participants had a slightly higher mean score in collaborative learning.

The mean scores of female and male participants in social presence were 30.4 and 36.9, respectively. The males had a higher mean score in social presence. The mean scores of female and male participants in satisfaction were 29 and 34.4, respectively. Again, the males had a higher mean score in satisfaction. The results of the t-test showed that the difference between the genders was only significant in the sub-dimension of satisfaction (t(28)= -2.13, p= .042).

Field Notes

Content analysis of the researchers' field notes yielded six categories.

The role of the facilitators

The need for guidance prevailed in the learning process in the MUVE. To meet this need, a facilitator was assigned to each group. The guidance of the facilitators helped to smoothly organize the project. In particular, their guidance focused on three issues: (1) problems with the group work, (2) instructions for using the environment (e.g. the

Table 3. *Satisfaction in 3D MUVE*

	Satisfaction Dimension	Satisfaction in 3D MUVE									
		Strongly Disagree		Disagreee		Neutral		Agree		Strongly Agree	
		f	%	f	%	f	%	f	%	f	%
1	I was able to learn new things while studying in 3D MUVE.	2	7	6	20	10	33	12	40	0	0
2	I was stimulated to do additional Research and study on topics discussed in 3D MUVE.	4	13	9	30	11	37	6	20	0	0
3	Discussions in 3D MUVE assisted me in understanding other points of view.	2	7	4	13	10	33	13	43	0	0
4	As a result of my experience in 3D MUVE, I would like to attend another similar 3D MUVE experience in the future.	3	10	9	30	5	17	11	37	2	7
5	Studying in 3D MUVE was a useful experience.	2	7	7	23	8	27	13	43	0	0
6	The diversity of meetings in 3D MUVE prompted me to participate in the discussions.	1	3	5	17	9	30	13	43	2	7
7	I put in a great deal of effort to participate the studies and discussions in 3D MUVE.	2	6.7	11	36.7	3	10	5	16.7	9	30
8	My level of learning that took place in 3D MUVE was of the highest quality.	9	30	7	23.3	7	23.3	5	16.7	2	6.7
9	Overall, the activities (group work) in 3D MUVE met my expectations.	6	20	13	43	7	23	4	13	0	0
10	Overall, the team coach in 3D MUVE met my expectations.	1	3	3	10	8	27	15	50	3	10
11	Overall, 3D MUVE met my expectations.	5	17	8	27	9	30	8	27	0	0

location of the meeting rooms, how to activate sound, how to deal with technical problems and so forth) and (3) the management of collaborative group work. Half of the participants reported in the questionnaire that the facilitators met their expectations, which suggests that their presence in the environment was useful.

The usability of the environment

A look at the profiles of the participants indicates that 60% of them were intermediate computers users and 40% had experience with MUVEs. Some participants were completely at ease with using the environment during the meetings. However, others did need instructions. Four aspects of the environment's usability were analyzed: moving around with the avatars, going anywhere in the environment by following instructions, using the menus, and customizing the avatars. The students did not have difficulty moving around the environment, and a large majority of them were able to arrive at the meeting rooms by following the instructions. However, some participants needed instructions to use the menus. In addition, some participants reported that it would have been better if they had been informed by the facilitators about how to use the menus. Most of the participants did not customize their avatars. Some who noticed this feature were unable to customize their avatars because they could not figure out how to do so.

Technical Problems

There were several technical problems with the MUVE during group work. These problems were generally associated with the software, the participants' equipment, and poor Internet connections. The problem with the software was that the participants were frequently disconnected from the environment. This happened whenever the participants logged in to the environment. Another problem with the software was related to sound control during voice communication. When a connection prob-

lem occurred, the software reactivated the sound of those participants who had been muted. This made it necessary to mute them again and again, making the meeting process ineffective. The problems with equipment involved malfunctioning microphones or the lack of microphones, which made voice communication impossible. Finally, the process was hindered by the physical environment where the participants connected to the Internet, the capacity of the network that they were using, and connection speed. For example, some participants had to use written communication as an alternative to voice communication since their speech was occasionally interrupted because of a slow connection. This was especially the case for participants who were connecting to the Internet in dormitories, where the connections were slow because of network congestion. Some participants chose not to use voice communication in order not to disrupt others since they were connecting to the Internet at a library.

Communication and Interaction

In a virtual environment, written and voice communication should be trouble-free so that they can substitute for physical meetings. However, the success of communication, one of the crucial factors in the effectiveness of collaborative learning in a virtual environment, was not uniform in Active Worlds. Written communication was mostly trouble-free, but this was not the case for voice communication. The reasons for the malfunction in voice communication were technical problems with the software, Internet connections, and the participants' equipment. For example, one technical problem with the software was that some participants, who could hear others and speak to them in their previous logins, were unable to use hearing and speaking functions properly even though they had not modified their equipment or Internet connection. This problem, which occurred on several occasions and in a variety of forms, could not be overcome by the participants, and instructions from the facilitators were ineffective most of the time. In addition, some participants failed to

use voice communication in the MUVE even though they could effectively use it in other environments, suggesting another technical problem associated with the software. Unlike the problems with the software, the problems with Internet connections and equipment were mostly overcome thanks to instructions from the facilitators or the individual efforts of the participants.

Collaborative Work

The MUVE was used to enable the groups to work in a collaborative learning environment. The participants usually collaborated to exchange ideas, shared the links to the materials and videos they had found and received instant feedback. Furthermore, the group members assigned tasks and checked each other's tasks, warning one another when necessary. In addition to the MUVE, Dropbox was also used for sharing files. The group members instantly revised their files in Dropbox in accordance with their discussions in the MUVE. In other words, they instantly put their ideas into practice in collaboration with the other group members. Using the MUVE and Dropbox together ensured that group work was based on collaboration. With its features of written and voice communication, the MUVE was used for collaborative learning, while Dropbox was used for sharing.

Meeting Location

A specific meeting location was assigned to each group, and all members were asked to be in that room at the time of the meeting. For each group, the photographs of the members and their facilitator were included in the design of the meeting room. The field notes indicate that the group members participated in some of the meetings by positioning themselves under their own photographs. In addition, some students warned others to position themselves under their photographs, and there were some discussions about why it was necessary to do so. In other words, some students concluded from the presence of photographs that all participants had to position themselves under their own photographs, whereas others did not. This type of positioning was common among female participants, while the male participants did not follow this practice.

Interviews

The interviews with the participants of the group project meetings in the MUVE generated 11 categories.

Avatars

Most of the participants did not customize the appearance of their avatars by modifying their clothing or hair. Only a quarter of the participants customized their avatars. Generally, they did so to stand out or to create a sense of belonging:

> Participant 6: "I changed the physical appearance of my avatar to create my own style."

> Participant 8: "It helped me to express myself better."

> Participant 9: "I did so to stand out among others. It also helped me to have a sense of belonging."

The reasons why the avatars were not customized were because the participants did not notice this feature, could not figure out how to do so or did not want to waste their time:

> Participant 11: "I did not notice it at all. I guess I did not feel the need."

> Participant 2: "I did not customize my avatar. This is because I did not know how to do so, and I did not care that much."

> Participant 12: "I noticed this feature, but I was not interested. I found it unnecessary and did not want to waste my time."

Most participants reported that being represented by an avatar made the environment more authentic and created the feeling of togetherness:

> Participant 7: "We were able to communicate in an environment which was almost authentic."

> Participant 12: "I can say that it was effective to know that there were others to communicate with."

Thanks to the avatars, the participants felt that they were communicating with real individuals. The participants reported that the avatars enabled them to feel as if they had been working side by side with others in the MUVE even though they were physically in different environments:

> Participant 3: "Although we were not side by side, they made us feel as if we were together in the virtual environment."

Meeting Rooms

The participants reported that they were motivated and saved time by the existence of specific meeting rooms for the different groups:

> Participant 8: "It motivated us and increased the level of seriousness in the meetings."

> Participant 4: "The fact that there was a specific room for us let us know where we would meet when we logged in to the environment, so we did not waste time."

The Effect on Social Presence

The participants reported that the meetings were able to create the feeling of togetherness except when there were technical problems:

> Participant 7: "When we spoke to each other, it was like normal communication."

> Participant 5: "It made us feel as if we were together."

They also reported that the avatars had a positive effect on social presence. The avatars helped them to have a sense of belonging to the environment. The participants also emphasized the importance of having somebody to communicate with in the environment:

> Participant 7: "Thanks to the environment, we could see one another."

Most participants stressed that having a meeting room exclusive to their group had a positive effect on social presence:

> Participant 10: "By meeting with all the members of the group in the meeting room, we were able to communicate easily with virtual representations of each other."

In addition, having a specific meeting room for each group created togetherness and enabled the participants to have a sense of belonging to the environment:

> Participant 10: "It ensured togetherness and helped us to have a sense of belonging to the environment."

> Participant 5: "It made us feel as if we were together there."

Some participants reported that their photographs in the MUVE enabled them not only to have a sense of belonging to the environment and their groups but also to meet in

the correct location when they first logged in to the environment:

> Participant 6: "The photographs indicated that the environment was ours."

> Participant 4: "With the photographs, I felt that I belonged to the group."

> Participant 1: "They helped me to understand that I was in the correct location when I first logged in to the environment."

Design Recommendations

To increase the authenticity of the meetings, the participants recommended that meetings be held outdoors and that the environment have office equipment such as desks and chairs:

> Participant 10: "Since it was an outdoor environment, it would have been better if additional equipment such as desks had been integrated."

In addition, the participants reported that the authenticity of the meetings could be increased by equipping the avatars with additional features such as the function of sitting on a chair.

Advantages

Thanks to the MUVE, communication contributed to the project processes. One advantage of the MUVE was the opportunity to discuss and share things. Participants mentioned that they could exchange their ideas by the help of MUVE:

> Participant 6: "We discussed content design. We learned what the other members were doing."

> Participant 8: "We used it to inform each other and generally to exchange ideas."

> Participant 6: "We were able to express our ideas simultaneously, and everybody could hear them, which ensured instant communication."

Another advantage of the MUVE was saving time:

> Participant 6: "Before we used this environment, we had many time-related problems, and we could not meet often."

Most of the participants reported that the MUVE made it easier for them to meet:

> Participant 9: "Since many of us were able to join, it made it easier for us to meet when we could not meet physically."

> Participant 12: "It enabled us to meet more often."

Since the MUVE was easily accessible from anywhere with a computer and Internet connection, the group members were able to participate in the project meetings no matter where they were physically located. During the interviews, the participants described it as another advantage of the MUVE to be able to meet by connecting at their home, dormitory, or other places especially when they could not meet physically:

> Participant 5: "When we could not meet in the classroom or outdoors, we were able to meet in the MUVE by connecting from anywhere."

Also, the participants said that the MUVE helped ensure collaboration among the students while they were working on their projects:

> Participant 5: "We found videos for the project. At the same time, we talked about how the design should be."

Technical Problems

Most of the problems with the use of the environment were technical. The participants' experience was hindered, in particular, by the inability to use voice communication regularly and effectively, problems with logging in to the software, and difficulty staying connected to it. Initially, there were too many users in the environment at the same time, which negatively affected the process. Then, the groups began to use the environment at different times. This helped overcome some of the problems, but the environment was still not trouble-free. The participants emphasized some of these problems:

> Participant 9: "There were frequent disconnections, and we were simply unable to overcome the problems with voice communication."

> Participant 11: "It would be better if access were denied when there were already 10 logins. Without this, crosstalk was inevitable."

Limitations

According to the participants, one of the limitations was the fact that the MUVE did not allow files to be shared. They also noted that they could not see what the other members of the group were doing, and they needed an additional instrument to do so:

> Participant 6: "One could not see what the others were doing."

> Participant 5: "In one way or another, we should have been able to see what we were doing and what outcomes we had. I do not think it was very effective in this respect."

The inability to share files in the MUVE affected collaborative learning among the group members:

> Participant 7: "To ensure collaboration, there must be a common folder in that environment. Your work should be filed in an environment. To do so, we need a folder such as Dropbox to put our common folders in. When we met in this environment, we needed to use Dropbox more effectively."

> Participant 12: "It might have been better if there had been a system for sharing folders."

To overcome this limitation, one participant proposed:

> Participant 12: "We could have opened files in the integrated web browser and thus presented and shared our files there."

Usability

The usability of a virtual environment is determined by how necessary instructions are, how easily people can find what they are looking for and how well they can interact with the interface. The evaluation of these factors provides clues as to the usability of the environment. In this study, the participants did not have much trouble with the usability of the virtual environment since they were already familiar with computers:

> Participant 5: "It was not that difficult to use the environment. It was like a game, so I did not have much difficulty."

> Participant 6: "I did not need any instructions."

One negative feedback on usability was that it was difficult for some participants to figure out how to customize their avatars:

> Participant 5: "We tried to figure out how to customize our avatars, but without success."

The Effect on Collaborative Work

The effect of project work in the virtual environment on collaboration was analyzed by examining the extent to which the participants were able to use the features of the environment. Although voice communication was not highly successful because of the technical problems, the participants were able to exchange ideas by means of written communication. They were able to discuss the topics specified in the meetings and share files using additional devices such as Dropbox, which suggested that they were involved in basic collaboration. Here is some positive feedback on this issue:

> *Participant 5: "It was good because we were able to share our ideas."*

> *Participant 7: "We exchanged ideas about the project design and conferred with one another about what to do to find the content."*

Even so, one participant reported that there was no effective control over the participants, which negatively influenced collaboration:

> *Participant 6: "It was only enough in terms of exchanging ideas, but you could not see what they were doing."*

Due to the technical problems with voice communication, most communication in the virtual environment was written, which the participants thought made the environment no significantly better than other similar platforms or devices:

> *Participant 11: "Well, we were able to communicate, but we can already meet our communication needs with other platforms such as Facebook."*

> *Participant 9: "In terms of communication and other factors, it was not much different from environments used for written communication."*

Nevertheless, the photographs aided communication during the sessions when voice communication was possible:

> *Participant 5: "The photographs were helpful since we could both hear and see the others."*

According to the participants, the MUVE contributed to collaborative learning in terms of exchanging ideas during the project design and implementation:

> *Participant 4: "It helped us to see where we were in the project and what we should do."*

> *Participant 7: "We exchanged ideas about the project design and conferred with one another about what to do to find the content. In this way, I realized what I was dealing with and what I was doing."*

Another participant reported that the MUVE did not help much with the project, and that it can only be used for exchanging ideas in certain courses:

> *Participant 2: "I do not think the environment contributed anything to the project at all. I think the environment can be used by students who cannot meet regularly for non-math courses, which call for more discussion. It is a good environment for exchanging ideas."*

In addition, the MUVE made the project meetings easier to schedule and attend. The participants reported that the MUVE enabled the group members to meet and collaborate:

> *Participant 10: "It made it easier for us to collaborate and meet even though we were in different locations."*

> *Participant 7: "When we could not meet face-to-face during the day, we were able to meet in the virtual environment and hold at least one group meeting."*

> *Participant 4: "We could not meet physically. I was far away, and some of our friends had other classes to attend. It was useful for meeting, although I did not participate much."*

One participant said that the virtual environment was less effective since it did not allow real-time display of work synchronized with the discussions:

> *Participant 5: "In one way or another, however, we should have been able to see what we were doing and what outcomes we had. I do not think it was very effective since we could not see the outcomes."*

The Advantages of Using Dropbox

One of the problems experienced by the participants was associated with sharing files. Working from different locations, the participants needed a way to share files. To meet this need, they used Dropbox. The data showed that the use of Dropbox for the project processes was useful for sharing and transferring information:

Participant 5: "In fact, it was good to have Dropbox since we needed to share many files as part of the project. Without Dropbox, we could not have exchanged these files since we were not side by side all the time."

> *Participant 1: "It helped a lot to share and transfer files."*

> *Participant 11: "Dropbox enables you to share things and follow what we are doing."*

Also, some participants reported that Dropbox made the project go faster:

> *Participant 7: "It made our work during the meetings proceed in an easy way."*

Some participants stressed that Dropbox made it easier to follow work on the project. By sharing files with Dropbox, they were able to track quickly what the group members were doing:

> *Participant 11: "It was effective because it allowed us to track changes quickly."*

The participants were able to follow their work by using Dropbox to access the files regardless of their locations:

> *Participant 12: "It helped us to follow what we were doing regardless of our locations."*

In addition, Dropbox enabled them to carry out their project work in collaboration:

> *Participant 6: "I was able to revise the changes made by my friends."*

The interviews revealed that another advantage of using Dropbox was related to time. The participants reported that they saved time by sharing files and keeping track of their work with Dropbox:

> *Participant 3: "It enabled what we were doing to be instantly transferred to others."*

> *Participant 12: "We achieved instant sharing."*

> *Participant 6: "Previously, we had to wait a day before our friends could see what we were doing."*

Dropbox facilitated instant sharing and helped a lot since the participants developed many animation files as part of

the project, and files with an ".exe" extension could not be sent by e-mail:

> Participant 4: "It enabled us to see the contents of the animations instantly."

The Advantages of Using Dropbox and the MUVE Together

Dropbox was used to compensate for the inability to share files in the MUVE. In this way, the participants were able to make simultaneous amendments to the files and discuss a shared file as if they were communicating face-to-face. These were the positive effects of using Dropbox and the MUVE together. Here is how one participant described the way these two environments complemented each other: Participant 11: "It was very useful. Without Dropbox, it was difficult to transfer files in the MUVE. In addition, since our activities were mostly visual, it took a long time to transfer them over the Internet. It was even impossible on some occasions. Using Dropbox in the MUVE enabled our project work to be completed smoothly."

Discussion

MUVEs are reported to be promising environments to support collaboration and communication (Schultze & Orlikowski, 2010). While the participants were carrying out collaborative learning activities in the MUVE, they felt as if they were working in an authentic environment. This was because they used their own avatars and their meeting rooms included their own photographs. In addition, the avatars and the meeting rooms created a feeling of togetherness. Avatars provide participants to engage in rich interactions that realizing the existence of the other team members in the environment. Avatars increases the sense of being with others by allowing participants to exchange ideas. Also, both avatars and design of meeting rooms provide authenticity by letting participants to navigate through the 3D world of MUVE (Bosch-Sijtsema & Haapamaki, 2014; Davis et al., 2009; Messinger et al., 2009; Tüzün, Alsancak-Sırakaya, Altıntaş-Tekin, Yaşar-Eren, 2016; Zhao, 2003). The MUVE also overcame the problem of meeting as a group. The participants reported that the MUVE provided them with the convenience of logging in to the meetings wherever they were.

One advantage of the collaborative learning experience in the MUVE was voice communication. It helped the participants to express their ideas and listen to the ideas of their group members. Through written and voice communication, the participants were able to discuss their project work in the MUVE. However, voice communication could not be used effectively, and the participants mostly used written communication. This was because of both connection problems and technical problems caused by the system. It has been reported that written communication environments are not as effective as voice and video communication in giving individuals the feeling of social presence. This is because the number of words per second in written communication is much lower than that of speech. When individuals only use written communication, there will be less discussion, which has a negative influence on decision-making processes (Sallnas, 2005). Therefore, project meetings in MUVEs must have voice or video communication for students to have a good experience.

Although the collaborative experience in the MUVE was generally useful, the meetings in the environment did not fully meet the expectations of the students. This was probably because there were disconnections and technical problems with logging in to and using the environment. In addition, the location from which the participants accessed the meetings in the MUVE affected their attendance and desire to participate. This is because different locations have different Internet speeds and bandwidths, which may affect the quality of connection to the MUVE. As a result, there were low attendance figures in some of the groups. A large majority of the participants (80%) considered face-to-face experience to be better than the MUVE experience for collaborative work on a group project. This was due to two main reasons. First, face-to-face communication is by nature more effective for interaction and sharing. Second, technical problems had a negative influence on the participants' performance in the MUVE. In face-to-face collaboration environments, participants can collaborate simultaneously since they are working around a table so there is a high level of understanding for shared activities. On the other hand, in technology mediated collaboration there might be low level of awareness for collaborators due to the missing visual cues (Poppe et al., 2017). Thus, technical problems that avoid effective communication among collaborators must be prevented in MUVEs to minimize the negative factors of distant collaboration in an online environment.

One limitation of the MUVE was that it did not offer a repository for sharing files. The participants needed to share their work instantly with their group members during the group meetings. Therefore, MUVEs should be integrated with file sharing environments. In this way, project work can be stored and shared in a common location. In addition, the opportunity to share and access project files from anywhere will enable group members to collaborate more quickly. Also, large-size files such as animation files can be shared with the group members. In this way, they will not have to meet physically to discuss the design of their projects, which, in turn, will enable them to save time.

In conclusion, project group meetings in MUVEs enable group members to exchange ideas and discuss through written and voice communication, creating a collaborative environment. These environments can be integrated with a file sharing platform so that group members can share files in an easier and faster way and thus enhance the effectiveness of their work. Since MUVEs cannot ensure satisfactory collaboration on their own, this integrated file sharing platform will enable project group members to work on project files simultaneously and exchange ideas regardless of time or location.

Conclusion and Implications for Future Research

In this study, the participants held project group meetings in the MUVE, where they were represented by avatars. They used both written and voice communication. As a complement to the environment, the participants used a file sharing platform, where project files were shared, followed and stored. Similar environments have been used in the literature for group work. These studies focus on social presence. Future research could use integrated MUVEs that involve voice, written, and video communication and allow file-sharing and whiteboarding. This can provide a synchronized virtual environment for users, and its effects on collaboration and social presence could be investigated. Future research could also study how these environments are used in software projects or social areas and thus identify how well they address a variety of needs.

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Longitudinal Impacts of Home Computer Use in Early Years on Children's Social and Behavioral Development

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Abstract

This study presents a pattern for Home Computer Use (HCU) and its relation to children's social and behavioural development during primary education. This study answers whether and how HCU (either educational or recreational) during primary school is related to children's social/behavioural development such as self-regulation, anti-social behaviour and pro-social behaviour. To do so, information about types and frequency of HCU from nearly 2000 children were analysed using hierarchical linear regression and path analysis on children ranging from 3 to 11 years old. Hierarchical linear regression was applied to study the main effects (i.e. direct effects) and the path analysis was used to investigate mediating (i.e. indirect effects) of HCU on children outcomes. The results showed that the use of HCU for playing games has a linear and negative association with children's Pro-social behaviour as reported by class teachers in Year 6, while the effects of other background characteristics were partialled out. Two other social/behavioural outcomes – anti-social behaviour and self-regulation – were not associated with children's HCU over and beyond what can be predicted based on children's prior social/behavioural profile and their demographic background characteristics. The theoretical and practical implications of these results are discussed.

Keywords: APrimary Education, Home Computer Use, Anti-Social Behaviour, Self-Regulation, Social/Behavioural Outcomes

Introduction

Rapid developments of ICTs, digital media and advanced educational technologies provide opportunities for people to deal with rapidly changing complex problems and issues (see Bose, 2009; Ersoy & Bozkurt, 2017; Noroozi, 2017; Noroozi & Mulder, 2017). Such fast developments of technologies have strong consequences for education in all levels from primary schools to university, since they provide learners with a bunch of digital tools to work alone and also cooperate with their learning partners both at formally at schools and informally at home (Coffey, 2017; Huda et al., 2017; Noroozi et al., 2011; 2012; 2013a, 2013b, 2013c, 2017).

Scientific research on the effects of media for children express how media can affect children's social and behavioural actions (Wartella, Caplovitz & Lee, 2004). The 21st century witnesses public debates on the role of digital media such as Home Computer Use (HCU) for children's social/behavioural development. The literature on the relation between HCU and social/behavioural development is rather limited and the findings are mixed. Most studied aspects of social/behavioural development are children's social interaction skills (Subrahmanyam et al., 2001), family dynamics and inside-family interactions (Mitchell, 1985), teacher-rated classroom behaviour (Malamud & Pop-Eleches, 2008), methods of interpersonal communication (Turow, 2000), increased self-regulation and independent learning abilities (Valentine et al., 2005), decline in social and psychological well-being such as increases in loneliness and depression and decreases in communication within the family (Kraut et al., 1998), improved attention skills and greater motivation and engagement (Passey et al., 2003), less pro-social behaviour (Wiegman & Van Shie, 1998), becoming desensitized to violent and aggressive behaviour due to the blurring real world and simulated virtual environment in the computer games (Turkle, 1995), anti-social and violent behaviour through excessive aggressive games playing (Irwin & Gross 1995). As the list above shows, the literature on the association between use of digital media and children's social/behavioural development reflects the last century controversies between technology's inspiration for enhancing children's aspects of development and concerns about the risks of exposure to inappropriate content and people.

Theoretical perspective on HCU and social/behavioural development

The academic literature on the theoretical underpinning of the relationship between ICT use and children's social/behavioural development is a continuation of the theoretical controversies on the media effects on individual's behaviour. The last century body of empirical and theoretical investigations on media and society, particularly on television and video games, reflects the debate between those who argued against the negative effects of media on people's social relationships and behaviour (Kraut et al., 1998) and those who were trying to show that the media have positive effects on people's social skills and behavioural outcomes too (Song & Keller, 2001) or the negative effects are negligible compared to other influencing factors (Shaw & Gant, 2002). Compared with older generation of media, digital technology of the 21st century seems to be a more powerful influencer on child's behaviour and social outcomes because, through interactivity characteristics of the new technologies, the children themselves 'actively engage in constructing and acting out social roles' (Wartella et al., 2004, p.10). The advocates of ICT for learning rely on the views of constructivists and socio- constructivists concerning learning with computers (see Säljö, 1998; Noroozi et al., 2016, 2017, 2018). The body of theoretical work on the relationship between new digital technologies and children's social/behavioural development is rather limited because of the novelty of the field and rapidly updating nature of technology and users' technological behaviour. In this section, the main theoretical frameworks put forward for the possible association between ICT use and selected aspects of children's social/behavioural development are discussed.

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ICT use and interpersonal relationships

The proponents of the idea that the internet use leads to less interpersonal relationships with family and friends and increases loneliness and depression explain this through two influencing factors of time and the differential nature of online social relationship as opposed to face-to-face (FtF) ones. Figure 1 shows this relationship. The time factor roots in studies on the effects of television in the scientific literature particularly the classic study done by Steiner (1963). In his studies, he theorised and empirically showed that television viewing occurs at the expense of socialising; 'the more spend watching television, the less time spent with family, friends and neighbours (Steiner 1963, p.230).
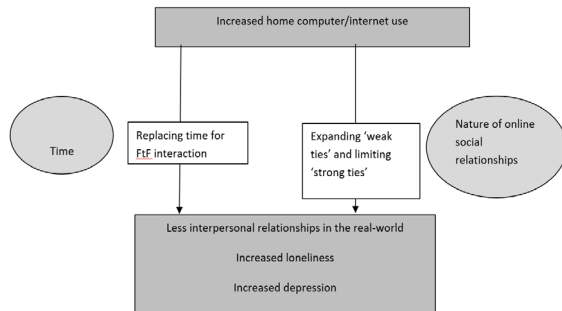

Figure 1. Theoretical explanation of adverse effects of the internet on social relationships

Similar explanation is given for less reported instances of face-to-face interactions of frequent internet users (Nie & Erbring 2000, Nie 2001; Subrahmanyam et al., 2000). They theorise that there are definitely constraints on one's time and they need to do a trade-off between hours spent on the internet use – even those hours used to communicate with friends and family – and other off-line social activities (PEW, 2000). A large body of empirical evidence supported the theory reporting that the internet time has even decreased the time people watch television, use other media such as talking with friends on the phone (George, 1997) and the time people take part in social events (Lo, Wang & Fang 2005). However, the time children spend on HCU is drastically increasing with widespread internet access while the overall number of hours of television viewing has not changed on more than a decade (Livingstone et al., 2009). Thus, it might indicate that the internet time comes from the time used to be spent playing and interacting with peers, siblings and parents (Nie & Erbring, 2000).

Figure 1 shows that another explanation for the negative impact of HCU on children's social relationships could be the differential nature of the interpersonal relationships while being online and in the face-to-face interactions. Initial theories on the differential nature of FtF interactions with those online were put forward in the last two decades when Computer-Mediated Communications (CMC) were diffusing into the workplace (Walther, 1995). Short, Williams and Christie (1976) proposed Social Presence Theory and later Sproull and Kiesler (1986) suggested Lack of Social Context Cues hypothesis to delineate the CMC and FtF social relationships. The former theory holds that the levels of social presence in a relational communication are determined by the medium of communication; 'the fewer the channels within a medium, the less attention is paid by the user to the presence of other social participants' (Walther, 1995, p. 95). As the computer-mediated communications (CMC), particularly of the time, did include a limited number of channels (e.g. only text in emails and not gestures, dress etc), they hypothesised that CMC is extremely low in social presence. Steinfield (1986) then suggested that decline in social presence of an interpersonal

relationship leads to the messages to be more impersonal. The impersonal nature of messages through CMC was associated with them to be less intimate and friendly (Culnan & Markus, 1987), and more likely to be blunt and hostile (Dubrovsky et al., 1991).

The theories reviewed above share the underlying premise that children's nature of social relations through the internet is different to the social interactions they have in the real world. McKenna and Bargh (2000) identified four major differences for online interpersonal relationships: one's greater anonymity, the greatly reduced importance of physical appearance and physical distance as "gating features" to relationship development, and one's greater control over the time and pace of interactions. These differences both help to explain potentially socially isolating impact of extensive HCU and the rival model in which internet is linked to increased social involvement and social support (Shaw & Gant, 2002). Anonymity, for instance, encourages deindividuation which means that one's self-awareness is extremely reduced by environmental conditions such as presence of a large number of people (McKenna & Bargh, 2000). Thus, an individual is less likely to care about what others think of his/her behaviour and therefore may behave more bluntly with greater aggressive responses.

On the other hand, the anonymity characteristic of CMC was shown to allow individuals to take greater risks in making disclosures to their internet friends. Moreover, being anonymous on the net was shown to provide children with the opportunity to successfully create and maintain 'wished for changes in their self-concept' (McKenna & Bargh, 2000, p.45). Anonymity was then hypothesised to enhance opportunities for children to engage in greater identity and role construction and to feel more comfortable for social interactions.

ICT and violent behaviour (anti-social behaviour). Children's aggressive and anti-social play and behaviours are repeatedly associated with their extent of playing computer games (see Browne & Hamilton-Giachritsis, 2005). The theoretical foundation of much of the work in this field roots back in the rich psychological/sociological literature on the impact of watching violent movies on television on children's behaviour which has produced a thoroughly documented set of studies since started five decades ago (Anderson & Bushman, 2001). However, studies show that, playing computer games have some important differences with viewing violent scenes on TV. First, the interaction affordances of the new technologies make it possible for users to 'actively' interact with violent imagery – for instance the active interaction of children with characters in today's sophisticated computer games. This is shown to have greater effects on the users because the child plays a more active role through having more control and more rewards for acting aggressively (Colwell & Payne, 2000). Second, the new video games possess an element of increasing 'realism' and life-like characters and situation which makes them more likely to have effects on children's heightened aggression in the real life (Kirriemuir & McFarlane, 2006). This might have a greater effect than abstract violence particularly for primary pupils who are developmentally- according to Piaget's stages of cognitive development – at pre-operational phase in which abstract concepts are difficult to understand (Piaget, 1978). A recurrent example for more mature pupils than those who are at the pre-operational phase of cognitive development is the game Grand Theft Auto III in which the player engages in a sexual practice with a prostitute and in a separate act is able to kill her to retrieve the fees (Kirriemuir & McFarlane 2006, p.11). Third, any aspect of behaviour - including anti- and pro- social behaviour – is a function

of a complex set of influencers from individual differences to family, social and environmental factors and playing video games is only a part of the big picture (Browne & Hamilton-Giachritsis, 2005). Therefore, the theoretical explanation of any possible links between playing computer games and increased incidences of anti-social behaviour requires further studies and the current body of literature, compared with what is available for the impacts of viewing violent movies, is limited.

The classical and current theoretical frameworks for the association between playing computer games and heightened anti-social behaviour do not suggest a causal relationship or a direction in the causation although there might be one. As playing violent games might stimulate aggressive behaviour, it is just as likely that children with a primary aggressive personality trait would prefer to play violent video games. This bi-directional relationship between exposure to violent computer games and individual differences (one's predisposition for violence, genetic predisposition, conduct and affective disorder) becomes more sophisticated when family, social and environmental factors are also added to the equation. Therefore, one can say that the effects of media violence will only account for a small proportion of an individual's aggressive behaviour as some systematic meta-analyses have shown.

ICT and Self-regulation. The literature on the HCU contains a body of studies reporting that ICT might facilitate the acquisition and improvement of self-regulated (or independent) learning strategies (Hadwin & Winne, 2001). The initial understanding of Self-Regulatory Learning (SRL) as a meta-cognitive strategy emphasised on regulation of cognitive processes such as acquiring the crafts of reading, writing and mathematics. SRL is beyond only monitoring of one's own cognitive activities but it encompasses motivational and emotional processes which are important in learning and do need to be regulated. Pintrich's (2000) framework is often cited in studies related to SRL processes and computer-based learning (Winters, Greene & Costich, 2008). He focused on four areas of SRL processes: a) cognition (e.g. goal-setting, planning, and enacting), b) behaviour (e.g. time management, help-seeking, maintenance and perseverance), c) context (e.g. monitoring of any change in conditions of the task) and motivation (e.g. interest, self-efficacy beliefs).

Having discussed the characteristics and importance of self-regulation strategies in learning, the question posed here is how the new digital technologies can facilitate the acquisition and improvement of these strategies. The answer is shown to be in the affordances of ICT in creating learning environments which scaffold self-regulation strategies (Schunk & Ertmer, 1999). For instance one obvious affordance of ICT is that it can afford several different representations of information including text, diagrams, graphs etc. (Winters, Greene & Costich, 2008). Other characteristics which have been applied to most Computer-Based Learning Environments (CBLEs) include, but not restricted to, creation of hypermedia learning environment (i.e. it allows users to select links between these representations or information (Dillon & Jobst, 2005), ICT affords direct manipulation of the representations (Reiber, 2005), it allows high level of learner control over the pace or mode of learning which at the same time assumes a responsibility for the learner for his learning (Azevedo, 2005), it provides constant feedback on any acts of the learner over the course of learning process (Facer et al., 2001).

The literature contains a body of investigations on the effectiveness of such computer-based tools for enhancing SRL. Although CBLEs are increasingly developed to be used by pupils to learn about conceptually rich domains, studies show that their effectiveness relies heavily on heightened level of users' SRL strategies (Lajoie, 2000). These strategies in turn are a function of individual and contextual processes (Rogoff, 1997). ICTs have important affordances to create learning environments which might foster SRL strategies and other meta-cognitive skills which will ultimately enhance children's performance. These affordances are present in both those environments particularly created for learning a subject or concept and the more generic HCU such as playing games and word-processing. This can be an important characteristic of ICT as self-regulated learners were reported to perform better in school subjects too (Whipp & Chiarelli, 2004). In addition, SRL strategies are shown to be crucial for developing life-long learners who have more opportunities for employment when they grow up (Selwyn & Facer, 2007).

To conclude, studies on the association between HCU and social/behavioural development, similar to those on school attainment, are limited by the ways in which HCU and behaviour outcomes measures are looked upon and operationalised. Moreover, such research is challenged by the rapidly changing nature of the new technologies. Recent advances in the technology industry have enabled affordances such as technology convergence (e.g. accessing the Internet on different platforms such the home computer, mobile phones and games consoles) which is required to be taken into account while studying children's HCU. The previous findings are mixed because similar to children's school achievement, there is no simple main effect of the ICT on a person's behaviour. There are many situational variables which interact with individual differences to produce people's behavioural outcomes (Mischel, 1973). Moreover, children and young people use the Internet in different ways which in turn lead to having different effects on them. This study takes this body of scholarship further with a longitudinal design to explore the relationships of the HCU and children's social and behaviourial development.

Methodology

The aim of this study was to investigate the relationship between HCU and children's social/behavioural development. Specifically the two main research questions were:

> 1. Is a child's social/behaviour development at the end of KS1 and KS2 related to the degree to which that child uses home computers educationally or recreationally?
>
> 2. How do effects of HCU and other predictors on social/behavioural development change from KS1 to KS2?

The rationale behind the research questions is the fact that past studies were mostly criticised for narrow conceptualisation of learning attainment through national tests. It is argued that use of technology promotes some forms of learning that are not captured by narrow tests at the end of Key Stages. These learning outcomes – sometimes referred to as 'hidden learning'- are personal attributes like SRL, motivation, independent learning and problem-solving abilities, critical thinking, collaborative learning and higher order skills that are not formally assessed by formal assessments. These qualities might have an ultimate indirect impact on children's performance in these tests (McFarlane et al., 2000). Moreover, there are concerns about possible negative effects of HCU on children's social competence. There have also been studies relating excessive computer use with lower scores on pro-social behaviour and higher levels of anti-social behavior.

Research Strategy

In order to address the research aims and questions a quantitative, longitudinal, value-added, large scale, multi-level modelling research strategy was adopted. A value-added strategy refers to the fact that in making statistical models children's prior attainment in Reading and Mathematics, and their prior social/behavioural profile were taken into account. In other words, the effects of HCU on children's outcomes are reported net of their baseline measure. This constitutes a model of progress over time and not merely at any one age. The data for this study came form the Effective Pre-school, Primary and Secondary Education (EPPSE) study which started in 1997 through funds from the Department for Children, Schools and Families (DCSF) (Sylva et. al., 2008) and ended in 2016. The EPPSE study aimed to investigate the effects of pre-school education and care on children's later development. The research team collected a wide range of data on children's developmental profiles, background characteristics related to the child themselves, their parents, and the pre-schools, primary and secondary schools children attended.

The EPPSE study is designed in a way to enable linking of three sets of data: information about children's attainment and development at different time points, information about children's personal, family and social characteristics, and information about the educational institutions (e.g. type and quality of pre-school settings, effectiveness measures of primary and secondary schools) that children attended.

In order to collect data to address the research project aims, the EPPSE team used various methods of data collection including one-to-one parental interviews, postal questionnaires for parents, questionnaires for pupils on their attitudes to school, teachers' assessment of pupils' social/behavioural development, one-to-one standardised assessments of children on their cognitive development and national assessment scores for end of each Key Stage. One area which the EPPSE team has collected data on and has shown it to be a strong predictor of children's cognitive and social development especially during the primary school period is the Home Learning Environment (HLE). This refers to the frequency of broadly educative activities that parents and children do in the home such as reading books, going on educational visits, using home computer and help with homework. HCU is the focal point of interest to this study. The sample of the study was stratified by geographical location and types of pre-school centre. Six Local Authorities (LA) in England in 5 regions (East Anglia, Shire Counties, Inner London, North East and Midlands) were selected strategically so that they cover urban, sub-

urban, and rural areas, and a range of social and ethnic backgrounds. From these 6 LAs 141 pres-school centres were then selected through stratified random sampling to include six main types of pre-school provision (play-groups, local authority or voluntary day nurseries, private day nurseries, nursery schools, nursery classes, integrated centres). This means that from each LAs about 20-25 centres were selected in a way that they covered all six main types of pre-school provision. Approximately 20 children from each centre were then randomly selected, thus giving a total of approximately 2800 children. After children were randomly selected from 141 pre-school centres and their families agreed to participate in the study (aged 3 to 4.3 years), children were assessed by a trained researcher in regard to their cognitive and social/behavioural development. This formed the baseline data for children and it was then followed by other cognitive assessments and social/behavioural reports at later stages up to the end of compulsory education. Background information about child, family and HLE characteristics were also obtained first through parental interviews (at entry to the study) followed by parental questionnaires (while children were in Y2, Y6, Y9, Y11).

Reliability of assessment measures were optimised using several strategies. Standardised cognitive tests and social behavioural scales which were tested for reliability in other studies were used at multiple Data on HCU by children on their own and with their parents were obtained through a questionnaire posted to families. The data were collected at two time points: first when children were in KS1 (Y1 and Y2) and then when they were coming to the end of KS2 (Y5 and Y6). Frequency questions were answered on a 5-point likert scale: 'never', 'hardly ever', 'occasionally', '1 or 2 times a week', 'everyday'. Questions on number of hours on a typical weekday were answered on a 4 point scale from 'less than an hour' to '5+ hours'.

Children's profile of social and behavioural development was created at multiple stages during the EPPSE study. First at entry to study (aged 3 to 4.3 years), children's social/behavioural adjustment was reported by pre-school centre staff using Adaptive Social Behavioural Inventory (ASBI). This assessment formed a baseline against which later progress and development was compared. Table 1 summarises all social/behavioural assessments which were applied to the EPPSE children from entry to study to the end of primary school. For the purpose of this study, children's social/behavioural data at entry to primary school, Year 2 and year 6 are used and data collection procedure for these three time points is explained below.

In order to conceptualise and test relationships between predictors and outcome variables statistical modelling

Table 1. *Children's social/behavioural assessments*

	Entry to study (age 3 to 4.3 years)	Entry to primary school (age rising 5 Ys)	Year 1(age 6+)	Year 2(age 7+)	Year 5(age 10+)	Year 6(age 11+)
Name of assessment	Adaptive Social Behavioural Inventory (ASBI) (Hogan et al. 1992)	Child Social Behavioral Questionnaire (CSBQ) which is a revised and expanded version of ASBI, devised by the EPPSE team	Strength and Difficulties Questionnaire (Goodman 1997) extended for the study	Strength and Difficulties Questionnaire (Goodman 1997) extended for the study	Strength and Difficulties Questionnaire (Goodman 1997) extended for the study	Strength and Difficulties Questionnaire (Goodman 1997) extended for the study
Assessment content	Social behaviour and emotional adjustment	Social and emotional behaviour, hyperactivity and settling-in-to-school	Self-regulation, hyperactivity, pro-social and anti-social behaviour	Self-regulation, hyperactivity, pro-social and anti-social behaviour	Self-regulation, hyperactivity, pro-social and anti-social behaviour	Self-regulation, hyperactivity, pro-social and anti-social behaviour
Administered by:	Pre-school staff	Class teacher	Class teacher	Class teacher	Class teacher	Class teacher

was applied. Predictors – or independent/explanatory variables – in this study are HCU and 13 covariates for which effects on outcome variables are studied. Outcome variable - or dependent variable – is social/behavioural outcomes (e.g. self-regulation, pro-social behavior, anti-social behaviour) in this study on which the effects of predictors are studied.

Findings

Bivariate regression analyses where there was no control of other influencing variables showed that out of four factors extracted for children's social/behavioural profile at the end of KS1, only two of them were statistically associated with children's HCU. 'Self-regulation' was positively associated with children's educational HCU, $r= .06$ (one-tailed), $p< .01$ and 'hyperactivity' was positively associated with children's frequency of HCU for recreational purposes, $r= .04$ (one-tailed), $p< .05$ (Table 2). However, in this preliminary correlational analysis HCU for educational and recreational use accounted for less than 0.5% of the variance in Self-regulation and Hyperactivity scores. Later multivariate analyses will explore this relationship in greater detail.

It is interesting to see that the direction of relationship between recreational HCU and the two negative behavioural profiles i.e. 'hyperactivity' and 'anti-social behaviour' were similar. This means that as children's frequency of playing games on home computers increased their rate of being reported as hyperactive and anti-social by teachers increased too. However, this association was not statistically significant.

Table 2. *Correlation between HCU and Social/behavioural outcomes in Y2*

		Self-regulation	Hyper-activity	Pro-social	Anti-social
HCU for educational purposes (HCUfE)	Pearson correlation	.06	-.007	.02	-.02
	Sig. (1-tailed)	< .01	ns	ns	ns
HCU for recreational purposes (HCUfR)	Pearson correlation	.002	.04	-.03	.01
	Sig. (1-tailed)	ns	< .05	ns	ns

Therefore on the basis of having a significant association with variables of primary interest to this study (i.e. HCUfE and HCUfR) it was decided that further analyses would focus on the scales of 'self-regulation' and 'hyperactivity'. Groups of children showed different patterns of social/behavioural profile at the end of KS1.

Table 3. *Two social/behavioural outcomes by groups of children*

Y 2 Social / behavioural		Self-regulation			Hyperactivity		
		n	mean	sd	n	mean	sd
Gender	Male	873	2.33	0.51	875	1.75	0.44
	Female	856	2.45	0.45	855	1.56	0.37
	Total	1729	2.39	0.48	1730	1.66	0.42
FSM	Yes	273	2.21	0.49	273	1.79	0.44
	No	1439	2.42	0.48	1440	1.63	0.41
	Total	1729	2.39	0.48	1730	1.66	0.42

As shown in Table 3 the mean scores for girls are somewhat higher for Self-regulation and lower for Hyperactivity. Free School Meals (FSM) used as an indicator of low income showed that children rated as eligible for FSMs

had relatively poorer behaviour ratings than other children. Results show a linear relationship between mothers' highest level of education and their Self-regulation scores in Y2 as rated by their class teachers. Results show a negative linear relationship between children's HLE and their Hyperactivity scores.

Table 4 summarises the associations between all covariates 4 and Self-regulation, Hyperactivity. The table shows that Self-regulation had a significant correlation with all covariates except 'number of siblings'. HLE, family's highest Socio-Economic Status (SES) and mother's education had the strongest linear link with the extent to which children were reported as 'self-regulated' by their class teachers. Hyperactivity was also significantly related to all covariates except 'ethnicity' and 'EAL'. The gender of the child had the strongest link indicating that boys were reported to be much more hyperactive than girls. Father's level of education was also significantly and negatively associated with hyperactivity scores of children, indicating that children whose fathers were less educated were reported as being more hyperactive by their teachers at the end of Year 2.

Table 4. *Pearson correlations between covariates and two Social/behavioural outcomes*

	Self-regulation Y2	Hyperactivity Y2	
Birth weight	.09**	-.08**	
Gender	.12**	-.22**	
Ethnicity	-.05*	ns	
EAL	.11**	ns	Individual Block
Developmental Problems	.11**	-.07**	
Health Problems	.05*	-.04*	
Behaviour Problems	.11**	-.13**	
Mother's education	.21**	-.14**	
Father's education	.18**	-.18**	
Family SES	-.22**	.15**	Family Block
FSM	.15**	- .14**	
Number of siblings	ns	-.06**	
HLE	.23**	- .18**	HLE Block

In order to see the progress that children made in their social/behavioural development from a prior point to their current status at the end of KS1 (aged 7), children's social/behavioural profile at entry to primary school was considered as their baseline measure. At entry to primary school, teachers completed the Child Social Behaviour Questionnaire (CSBQ), an instrument developed by the EPPSE team from ASBI (Hogan et. al. 1992). The instrument had 45 items rated on a 5-point scale (1= rarely/never to 5= almost always). Principal Components Analysis extracted 6 underlying factors (Appendix E). Each child's score for each of the factors was calculated by averaging the ratings given by teachers for the questions that formed that factor. In order to see the consistency of responses Cronbach Alpha was used. As a rule of thumb values above 0.60 were considered appropriate. In order to select the proper base line measures for Self-regulation and Hyperactivity outcomes, the correlations between all 6 factors and these two outcome measures were studied. As shown in the Table 5 for Self-regulation and Hyperactivity, the measure of Independence and Concentration (I&C) at the start of primary school was the strongest predictor. Note that the link between Hyperactivity and I&C was negative meaning that children rated more highly in terms of Independence and Concentration at entry to primary school, were less likely to show raised scores for Hyperactivity later, at the

end of Y 2. On the basis of this, I&C factor at entry to primary school was considered as the baseline measure for both Hyperactivity and Self-regulation at end of KS1.

Table 5. *Correlation between entry to school measures and the two social/behavioural outcomes in Y2*

		Self-regulation Y2	Hyperactivity Y2
Independence & Concentration	Pearson correlation	.40	-.42
	Sig. (1-tailed)	<.01	< .01
Co-operation & Conformity	Pearson correlation	.31	-.38
	Sig. (1-tailed)	< .01	< .01
Peer Sociability	Pearson correlation	.27	-.08
	Sig. (1-tailed)	< .01	< .01
Anti-social/ worried	Pearson correlation	-.15	.30
	Sig. (1-tailed)	< .01	< .01
Empathy & pro-social	Pearson correlation	.31	-.26
	Sig. (1-tailed)	< .01	< .01
Confidence	Pearson correlation	.30	-.14
	Sig. (1-tailed)	< .01	< .01

Association between HCU and children's social/behavioural development

Table 6 colour-codes the relevant covariates for each outcome variable in KS1. Yellow cells highlight those variables selected to be included in the models. Blue cells highlight covariates that had a significant association with relevant outcome variable at least at 95% CI but were not included in models because the association was weak, past studies did not use them frequently or another variable indicating similar factor was selected.

Table 6. *Covariate analysis and selection*

	Social/behavioural outcomes		
	Self-regulation Y2	Hyperactivity Y2	
Birth weight	(blue)	(blue)	Individual Block
Gender	(yellow)	(yellow)	
Ethnicity	(blue)		
EAL	(yellow)		
Developmental Problems	(blue)	(blue)	
Health Problems	(blue)	(blue)	
Behaviour Problems	(yellow)	(yellow)	
Mother's education	(yellow)	(yellow)	Family Block
Father's education	(blue)	(blue)	
Family SES	(yellow)	(yellow)	
FSM	(yellow)	(yellow)	
Number of siblings		(blue)	
HLE	(yellow)	(yellow)	HLE Block

Key: ☐ *Non-significant,* ▨ (yellow) *Significant and chosen for inclusion in model,* ▨ (blue) *Significant at least at 95% CI (i.e. p< .05*

Findings for Self-regulation in Y2

There was data for 1729 children on their Self-regulation scores. The distribution did not fit a normal distribution and it was skewed to the right (skew= -.61). For the same reasons discussed for Reading and Mathematics, parametric test of linear regression was used to model the data. Table 7 reports standardised regression coefficients (β) of significant predictors for each model as well as the amount of variance explained by each model. As shown in the table the amount of variance explained by each model increased as more predictors were added into the model. Constant for each model is also reported. The level of educational and recreational uses of home computers in KS1 was not associated with their Self-regulation scores in Y2 after controlling for their prior Independence and Concentration profile at entry to primary school, individual, family and HLE characteristics. The association between HCU for educational purposes and Self-regulation was significant and positively related only in bivariate analysis where there was no control of any other influencing variables, (β= .08, p< .05). Recreational HCU, as shown in Section 6.2.2.1, showed no significant link with children's Self-regulation scores.

Children's prior profile in Independence and Concentration at entry to primary school was the strongest predictor of their Self-regulation scores at the end of Y2 in all models. This was followed by children's early-years HLE scores, family SES, gender, reported early-years behaviour problems, mother's level of education and family economic status as measured by eligibility for Free School Meals. Girls, those who did not have any early-years behaviour problems, children from more advantaged families (higher SES, educated parents and not eligible for FSMs) with richer HLE showed higher scores of Self-regulation after controlling for their baseline Independence and Concentration profile at entry to primary school.

Findings for Hyperactivity Y2

The second measure of social/behaviour development which showed a significant relationship with one measure of HCU in bivariate analyses was Hyperactivity. There was a weak but significant association of r= .04, p< .05 between HCUfR and Hyperactivity indicating that children who played more on home computers showed more Hyperactivity related behaviour as reported by their teacher. It is important to remind that lower scores on Hyperactivity scale were considered a better behaviour rather than higher scores. There are data on Hyperactivity profile of 1730 children when they were 6/7 at the end of KS1. The distribution was positively skewed (skew= .93) indicating that a great proportion of children were not reported by their Y2 teachers as being Hyperactive. Due to similar reasons discussed for Reading scores, parametric test of linear regression was used to make statistical model. Table 8 reports standardised regression coefficients (β) of significant predictors for each model as well as the amount of variance explained by each model.

The strongest predictor of Hyperactivity in Y2 was children's reported profile on Independence and Concentration scale at entry to primary school. Children who were reported to be more independent at age rising 5 at entry to primary school were reported by their Y2 teachers to be less Hyperactive. Boys were reported to be more Hyperactive after controlling for their other background characteristics like family SES. Children from poorer family as assessed by eligibility for FSMs were also reported be more Hyperactive compared to their peers who were not eligible for FSMs after taking into account other variables. Children who were reported by their parents during parental interviews to have behaviour problems at early

Table 7. *Hierarchical linear regression results for Self-regulation Y2*

	Model 1 (HCU only)	Model2 (Baseline measure)	Model 3 (Individual block)	Model 4 (Family block)	Model 5 (HLE block)
HLE					.09**
Mother's education				.07*	.05#
SES				-.08**	-.07*
FSM				.05*	.05*
Gender			.06*	.08**	.06*
EAL			.08**	.05*	ns
Behaviour problems			.07**	.05*	.06*
Independence & Concentration at entry to school		.41**	.38**	.35**	.34**
HCU for Education	.08*	ns	ns	ns	ns
HCU for Recreation	-.03 ns	ns	ns	ns	ns
Variance explained (R-squared)	.004	.170	.184	.206	.212
Constant	.015	-.002	-.005	-.009	-.011

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

Table 8. *Hierarchical linear regression results for Hyperactivity Y2*

	Model 1 (HCU only)	Model2 (Baseline measure)	Model 3 (Individual block)	Model 4 (Family block)	Model 5 (HLE block)
HLE					-.04ns
Mother's education				-.03ns	-.02ns
SES				.04ns	.04ns
FSM				-.07**	-.07**
Gender			-.14**	-.16**	-.15**
EAL			-.08**	-.07**	-.07**
Independence & Concentration at entry to school		-.44**	-.41**	-.39**	-.38**
HCU for Education	-.05ns	.007ns	.03ns	.05#	.06*
HCU for Recreation	.07*	.03ns	-.008ns	-.03ns	-.02ns
Variance explained (R-squared)	.003	.196	.222	.233	.234
Constant	-.013	.004	.005	.009	.010

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

Table 9. *Comparing HCU effect sizes on KS1 outcome measures*

	HCU and KS1 Outcomes	Baseline measure and Covariates	R^2 (for Model 5)	Model 2		Model 5	
				HCUfE β	HCUfR β	HCUfE β	HCUfR β
SOCIAL / BEHAVIOURAL	Self-regulation	Independence &Concentration, gender, EAL, behaviour problems, mother's education, SES, FSM and HLE	.21	ns	ns	ns	ns
	Hyper-activity	Independence &Concentration, gender, behaviour problems, mother's education, SES, FSM and HLE	.23	ns	ns	.06*	ns

years of life scored higher on Hyperactivity scales in Y2 after the effects of other variables were partialled out.

Table 9 compares effect sizes (or standardised *β* Coefficients) of HCU for educational (HCUfE) and recreational (HCUfR) purposes on two social/behaviour outcomes (Self-regulation and Hyperactivity) at the end of KS1 using hierarchical linear regression. Surprisingly educational HCU showed a statistically significant impact on Hyperactivity of children. Frequent users of home computers for educational purposes were reported to be more hyperactive after controlling for all other things. Recreational HCU was not a significant predictor of Hyperactivity and Self-regulation. Table 9 also shows that family characteristics (such as SES, mother's qualification and economic status) and parenting (i.e. HLE) are the ones which made the effects of HCU on children's development non-significant.

Longitudinal effects

An extended version of Strength and Difficulties Questionnaire (Goodman 1997) was completed by Y6 teachers for every child. The questionnaire captured social adjustment of children and their behaviour profile at age 11. Principal Component Analysis and Confirmatory Factor Analysis were applied to summarise the questionnaire items into underlying dimensions. Four main factors were extracted: Self-regulation, Hyperactivity, Pro-social and Anti-social behaviour. Table 10 shows the four factors, the corresponding items and the factor loadings. Factor scores for each child were then calculated by averaging the rating given by the teacher for the questions that form each factor. A measure of internal consistency between the items of a given factor, Cronbach Alpha, was also used to confirm that teachers' responses to related questions were all consistent.

Self-regulation in Year 6

Data on the self-regulation profile of 1791 children were available in the sample. Table 11 reports that educational HCU showed a significant association with raised scores in Self-regulation in Year 6 after controlling for their prior self-regulatory profile in Year 2 and their individual child

Table 10. *Factor loadings for Y6 Social/behavioural outcomes*

Items	Factor 1 Self-regulation	Factor 2 Hyper-activity	Factor 3 Pro-social behaviour	Factor 4 Anti-social Behaviour
Likes to work things out for self; seeks help rarely	.56			
Does not need much help with tasks	.65			
Chooses activities on their own	.59			
Persists in the face of difficult tasks	.45			
Can move on to a new activity after finishing a task	.66			
Open and direct about what she/he wants	.47			
Confident with others	.65			
Shows leadership in group work	.73			
Can take responsibility for a task	.71			
Considerate of other people's feelings			.65	
Shares readily with other children (treats, toys, etc.)			.52	
Helpful if someone is hurt, upset or feeling ill			.63	
Kind to younger children			.43	
Often volunteers to help others (teachers, other children)			.49	
Offers to help others having difficulties with a task			.51	
Sympathetic to others if they are upset			.60	
Apologises spontaneously			.48	
Restless, overactive, cannot stay still for long		.65		
Constantly fidgeting or squirming		.56		
Easily distracted, concentration wanders		.49		
Thinks things out before acting		-.47		
Sees tasks through to the end, good attention span		-.54		
Quickly loses interest in what she/he is doing		.60		
Gets over excited		.64		
Easily frustrated		.71		
Impulsive, acts without thinking		.70		
Can behave appropriately during less structured sessions		-.53		
Fails to pay attention		.65		
Makes careless mistakes		.58		
Often fights with other children or bullies				.65
Often lies or cheats				.48
Steals from home, school or elsewhere				.56
Vandalises property or destroys things				.45
Shows inappropriate sexual behavior toward others				.47
Has been in trouble with the law				.36

characteristics. However after the effects of family and HLE were partialled out, the association became non-significant. The strongest predictors of children's Self-regulation profile in Year 6 were their social adjustment score in Year 2, their mothers' highest level of education, the aspect of HLE related to child's independent learning activities in the home, family SES and gender (favouring girls).

Self-regulation in Year 6

Data on the self-regulation profile of 1791 children were available in the sample. Table 11 reports that educational HCU showed a significant association with raised scores in Self-regulation in Year 6 after controlling for their prior self-regulatory profile in Year 2 and their individual child characteristics. However after the effects of family and HLE were partialled out, the association became non-significant. The strongest predictors of children's Self-regulation profile in Year 6 were their social adjustment score in Year 2, their mothers' highest level of education, the aspect of HLE related to child's independent learning ac-

tivities in the home, family SES and gender (favouring girls)

Pro-social behaviour in Year 6

Data were available on the aspect of social/behavioural profile related to Pro-social behaviour for 1791 children. Table 12 shows significant predictors of children's Pro-social behaviour at the end of KS2. Bivariate analyses showed a significant and positive association between Pro-social behaviour of children in Y6 and their educational HCU while a significant, stronger but negative association with recreational HCU. HCU to play games remained a significant predictor of children's Pro-social behaviour after controlling for their prior pro-social profile in Year 2 and their demographic characteristics. It indicated that the more children played on computers, the less they were reported to have Pro-social behaviour in the classroom after controlling for all other covariates. The strongest predictors of pro-social behaviour were children's baseline measures in Year 2, gender (favouring girls) and their HLE in KS2.

Table 11. *Significant predictors of Self-regulation Y 6*

	Model 1 (HCU only)	Model2 (+Baseline measure)	Model 3 (+Individual block)	Model 4 (+Family block)	Model 5 (+HLE block)
KS2 HLE Child's independent learning activities					.08**
Mother's education				.13**	.12**
SES				-.06*	-.06*
Gender			.07**	.08**	.07**
Self-regulation Year 2		.52**	.51**	.47**	.45**
HCU for Education	.11**	.08**	.06*	ns	ns
HCU for Recreation	-.08**	-.04ns	-.01ns	ns	ns
Variance explained	.01	.28	.29	.32	.33
Constant	.02	.006	.005	.002	.000

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

Table 12. *Significant predictors of Pro-social behaviour Y6*

	Model 1 (HCU only)	Model2 (+Baseline measure)	Model 3 (+Individual block)	Model 4 (+Family block)	Model 5 (+HLE block)
KS2 HLE Child's independent learning activities					.07*
Mother's education				.04#	ns
Gender			.20**	.20**	.18**
Ethnicity			-.05*	ns	ns
Pro-social behaviour Year 2		.39**	.35**	.34**	.34**
HCU for Education	.10**	.07*	.02ns	ns	ns
HCU for Recreation	-.16**	-.11**	-.05*	-.05*	-.05*
Variance explained	. 02	.17	.21	.22	.23
Constant	. 02	.02	.02	.01	.01

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

Table 13. *Significant predictors of Hyperactivity in Y6*

	Model 1 (HCU only)	Model2 (+Baseline measure)	Model 3 (+Individual block)	Model 4 (+Family block)	Model 5 (+HLE block)
KS2 HLE Child's independent learning activities					-.06*
Mother's education				-.14**	-.13**
FSM (being eligible)				-.06*	.06*
Gender			-.19**	-.20**	-.19**
Early years behavioural problems			-.05*	-.04*	-.04*
Hyperactivity Year 2		.50**	.45**	.43**	.42**
HCU for Education	-.08**	-.05*	-.01ns	ns	ns
HCU for Recreation	.15**	.10**	.04ns	ns	ns
Variance explained	.02	.27	.30	.32	.33
Constant	-. 03	-.02	-. 02	-. 02	-. 02

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

Hyperactivity in Year 6

Data on the Hyperactivity profile of 1792 children were available in the sample. Bivariate analyses showed that educational HCU had a negative and significant association with children's hyperactivity scores assessed by their Year 6 class teachers (Table 13). Recreational HCU, by contrast, showed a positive association with hyperactivity scores indicating that children who played games more frequently on HCU were more likely to be rated as hyperactive by their class teachers. This relationship pattern remained the same after children's prior hyperactivity profile in Year 2 was also taken into account. However, after the effects of individual child, family and HLE characteristics were partialled out, these significant associations faded away. The strongest predictors of children's hyperactivity were their prior profile in the same social/behavioural domain in Year 2 followed by gender (boys were more likely to be reported as hyperactive), their mother's level of education (children from less educated mothers had higher scores in hyperactivity), eligibility for Free School Meals (FSM) as an indicator of family poverty, having behavioural problems during pre-schools as reported by parents and HLE (negatively associated with child's independent learning activities in the home).

Anti-social behaviour in Year 6

Data on the Anti-social behaviour of 1790 children were reported by their class teachers in Y6. Table 14 shows that in initial bivariate analyses recreational HCU was significantly associated with raised scores in anti-social behaviour as assessed by class teachers in Year 6. By contrast levels of educational HCU were negatively associated with

Table 13. *Significant predictors of Hyperactivity in Y6*

	Model 1 (HCU only)	Model2 (+Baseline measure)	Model 3 (+Individual block)	Model 4 (+Family block)	Model 5 (+HLE block)
KS2 HLE Child's independent learning activities					-.13**
Mother's education				-.07*	-.06*
FSM (being eligible)				-.08**	.08**
Gender			-.11**	-.12**	-.08**
Anti-social behaviour Year 2		.37**	.36**	.34**	.33**
HCU for Education	-.07*	-.04ns	-.02ns	ns	ns
HCU for Recreation	.07*	.08**	.04ns	ns	ns
Variance explained	.005	.14	.16	.17	.19
Constant	-.04	-.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

incidents of children being reported to have anti-social behaviour. This relationship was consistent for HCU to play games even after controlling for children's prior anti-social behaviour profile in Year 2. However, after effects of individual, family and HLE characteristics were taken into account the linear significant association between scores in anti-social behaviour and both types of HCU disappeared.

Discussions and Conclusion

For social/behavioural development in primary school, children's prior social/behaviour profiles at age 3+ and 7 were the strongest predictors of their social/behavioural development at age 7 and 11 respectively. There were also marked gender differences on all measures of social/behavioural development. Girls were rated by their teachers as displaying more 'self-regulation' and 'pro-social' behaviour than boys, whereas boys were rated more highly on 'hyperactivity' and 'anti-social' behaviour than boys. Comparing the effect sizes across the two key stages show that gender effects increase on all measures of social/behavioural development as children grow up. Children who were reported by their parents to have behavioural problems at pre-school age showed lower self-regulation behaviour and more hyper-active behaviour at age 7 and 11 compared to those who had no early years behavioural problems. In terms of effect sizes, they reduced as children grew up from Year 2 to Year 6. Family socio-economic status was significantly associated with raised reported levels of self-regulation and the strength of the effect decreased as children grew older. Mother's level of education was a significant predictor for all measures of social/behavioural development except 'pro-social' behaviour after controlling for the effects of other factors in primary school. Higher mother's educational levels were associated with higher teacher rated self-regulation and lower levels of hyperactivity and anti-social behaviour. The magnitude of effect sizes related to mother's educational level increased in primary school period. Eligibility for Free School Meals as a proxy for family poverty showed a negative association with self-regulation and a positive association with hyperactivity and anti-social behaviour. This means that poorer children were reported by their teachers to show lower levels of self-regulation in Year 2 while they showed higher levels of hyperactivity in Years 2 and 6 and higher levels of anti-social behaviour in Year 6. The comparison can be made for only hyperactivity for which FSM was significant for both Years 2 and 6. It showed a slight decrease of .01 from Year 2 to Year 6. Finally HLE showed a positive linear association with teacher rated raised scores of self-regulation and pro-social behaviour and a negative association with hyperactivity and anti-social behaviour. Those children who had higher scores in early years HLE reported by their teachers to be more self-regulated in

Year 2. And those children who were reported by their parents to have more independent learning activities in the home in KS2 were also reported to show higher levels of self-regulation and pro-social behaviour and lower levels of hyperactivity and anti-social behaviour in Year 6.

Data from the current study were congruent with the first group of studies only in regard to the negative contribution of using home computers to recreate (i.e. playing games) during KS2 to children's level of pro-social behaviour in Year 6. This negative influence is the net effect of HCU for recreational purposes net of children's prior profile in Year 2 and the contribution of child individual, family and HLE characteristics. The measure of pro-social behaviour in the present study represents child's behaviour in Year 6 such as 'considerate of other people's feelings', 'kind to younger children', 'offers to help others having difficulties with a task'. Reviewing the emerging trends in the study revealed that children's HCU to play games had a steep increase from age 6/7 to age 10/11 and this was relevant mostly to boys. At the same time, boys scored lower than girls in measures of pro-social behaviour in both Year 2 and Year 6. One might infer that the negative contribution of HCU for recreational purposes to pro-social behaviour is related to the increased level of games playing as children grew older because the statistical model controlled for gender effects. The mechanism why and how games playing might cause decline of children's social/behaviour cannot be deduced from the data in this thesis. However, some theoretical models maintain that extensive games playing – particularly games which contain an aggressive theme – might desensitise children to their peers' suffering (Anderson & Bushman, 2001) as this principle is now included in training military forces to make them indifferent to their target's suffering.

One further finding from the current study was the significant association between educational use of home computers during KS1 and raised level of children's hyperactivity in Year 2 as reported by their teachers. This finding is surprising to the researcher and cannot be explained by the contextual literature in the field. Therefore, it requires a further study to understand this association. It is worth remembering that in KS1 the educational HCU was only reported about parents' HCU with children and the frequency of use was relatively low.

Two other social/behavioural outcomes – anti-social behaviour and self-regulation – were not associated with children's HCU over and beyond what can be predicted based on children's prior social/behavioural profile and their demographic background characteristics. These results are particularly important as there is a public concern over the negative influence of games playing

on children's increased level of aggression. The findings here are compatible with some studies such as Fleming & Rickwood (2001) which reported no association between moderate uses of computers for recreation and anti-social behaviour. Frequency of recreational HCU among the sample of the present study, therefore, should be considered as moderate rather than extensive. One further explanation for the dissociation between HCU and measures of anti-social behaviour and self-regulation might be the existence of relatively more important factors in the equation such as family and HLE characteristics. The step-wise inclusion of these factors also confirms this explanation as the inclusion of family SES, mother's level of education and HLE characteristics made the initial significant association non-significant. Family contribution might be in the form of at-home rules and regulation about the time and types of HCU, making HCU a shared family practice rather than an individual experience (Holloway & Valentine, 2003). Further qualitative studies are needed on the current sample on the parents and children's home computing behaviour such as setting and following any home computer regulations.

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The Effect of "Whatsapp" Usage on the Attitudes of Students Toward English Self-Efficacy and English Courses in Foreign Language Education Outside the School

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Abstract

The aim of this study is to examine if using WhatsApp actively in English outside the school has any effect on the students' attitudes and self-efficacy belief on English course. In this study, a sequential explanatory pattern was used. In order to obtain quantitative data, one group pretest-posttest design was used. The participants consist of 11th grade students studying in an Anatolian High School in the center of Sivas. The implementation of the study lasted eight weeks. In terms of the experiment, WhatsApp meetings were held twice a week for evaluating the achievement of 11th grade English course. "English Self-Efficacy Scale" and "Attitude toward English Scale" were applied before and after the experiment. In addition, semi-structured questionnaire was used in order to get the opinions of the students about the implementation at the end of the experiment. The results of the study revealed that using WhatsApp outside the course leads to a significant differentiation in the self-efficacy beliefs of the students for both reading and listening. The data obtained from qualitative processes also confirm this. In addition, it shows that the practice has a statistically meaningful effect on students' attitudes toward the course. The data obtained from the qualitative processes have proved that the implementation is influential in the emotions such as happiness, joy, excitement, pride and that the students considerably support the use of this implementation.

Keywords: WhatsApp, Language Teaching, Attitude, Self-efficacy Belief

Introduction

Certainly, ability to speak a foreign language is very important in every aspect of life as well as to be able to follow developments around the world. Hence, the foreign language education occupies a significant place in Turkey as in other countries of the world (Akkaş & Coker, 2016). However, it is commonly admitted that foreign language education in our country doesn't realize its purposes. After studying a foreign language for 10 years including secondary school, it is observed that majority of the students are still at the beginner level (Demirpolat, 2015). This is also apparent in the English proficiency levels in the English Proficiency Index (conducted by EPI) by many countries (EF EPI, 2018). According to data of 2018, Turkey ranks 31th among 32 countries in Europe while it ranks 73th between Nicaragua and Jordan among 88 countries in the world. As Turkey ranked 32nd among 44 countries in 2012, this shows that the current problem is continuing (EF EPI, 2018). This issue was largely investigated with many studies in our country and it is observed that the problem has many various dimensions. Among the factors affecting language teaching, it has been noted that there are several factors such as students' attitude toward language learning, motivation, concerns, insufficiencies about teaching tools and equipment, the fact that the lessons are strongly based on theoretical knowledge, the fact that the students feel reluctant to learn a language, and finally inadequate use of technology (Aydın & Zengin, 2008; Baran & Halıcı, 2006; Çelebi, 2006; Gedikoğlu, 2005; Gökdemir, 2010; Kazazoğlu, 2013; TEPAV, 2014).

In addition to cognitive factors that influence success in language teaching, affective factors such as attitude, motivation, and self-efficacy are significant as well. In this respect, one of the factors that should be analyzed in foreign language teaching is self-efficacy beliefs. Self-efficacy is defined as one's belief in one's ability to succeed in specific situations or accomplish a task (Bandura, 1977). Zimmerman (2000), on the hand, defines the self-efficacy as the judgments of a person to accomplish a certain task, it does involve the physical or psychological characteristics of the person, not personal qualities. Hence, foreign language self-efficacy perception can be explained as the judgments (Yanar, 2008) of individuals about their ability to regulate and perform the essential activities in order to achieve a certain performance in a foreign language. Self-efficacy constitutes the need to perform in events that may affect the lives of individuals. This condition influences one's feelings, thoughts, motivations, and behaviors (Bandura, 1977). Thus, self-efficacy is a multifaceted phenomenon. Therefore, self-efficacy belief may vary according to the situations and events. For example, a student's self-efficacy in language learning may differ from his/her self-efficacy in physical learning. People with strong self-efficacy are stubborn on the incidents and challenges they encounter, they make more effort and have powerful resistance. This certainly affects the academic success of the person as well (Yılmaz, Yiğit, & Kaşarcı, 2012).

Another affective feature influencing the students' success in language teaching is the attitudes of students. Attitude is defined as the mental state of readiness (Alport, 1954). Gardner (1985) defined the attitude as an evaluative reaction on the basis of the individual's beliefs or opinions. Many studies have been conducted on the impact of attitude on academic success in foreign language education and a strong relationship has been ascertained between attitude and achievement (Bartram, 2010; Kazazoğlu, 2013; Levin, Naama, & Zipora, 1991). In addition, it was noted that the attitudes of students have an essential role in the readiness level of the students (Ocak & Karakuş, 2014). Hence, it can be stated that self-efficacy and attitude are significant in teaching English to students and therefore, self-efficacy and attitude should be

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taken into consideration in the preparation of educational activities and education programs.

The significance of attitudes and self-efficacy experienced in face-to-face educational environments is also valid for distance education applications. Because networks have become stronger in today's technology. Hence, the technology is now used extensively in education and training environments. One of the most critical approaches explaining distance learning on networks that are used for educational purposes is the "Connectivism approach". As the pioneer of this approach, Siemens (2006) asserts that when students use digital tools for communication, an environment has been built to learn, to establish dialogues for learning and to internalize this learning as well. According to Siemens, a connection created in this way allows students to develop the ability to create new information in time (Siemens, 2006). Connectivism theory comprehends learning as a process that can be actualized and developed through the interaction of students with each other in digital environments rather than as an individual activity. Siemens also affirmed that the capability to communicate with others and the capacity to establish networks are essential in ensuring the continuity of information flow (Siemens & Tittenberger, 2018). Siemens (2006; quoted Gökmen, Duman, & Horzum, 2016) declares that the learning capacity of individuals is more prominent than the known capacity in the connectivism approach that is based on the capability of the individuals to observe the connection between the fields, ideas and concepts. And he also mentions that communities, e-mails, web searches, blog reading, and chats can be used to implement the principles of the connectivism approach.

Information and communication technologies (ICT) are required in order to implement the connectivism approach in education. The unimaginable speed of information and communication technologies considerably affects every aspect of our lives. In accordance with this change and progress, the use of ICT in our learning life has become undeniable and has been used in many parts of the world, particularly in the United States since the beginning of the 1980s (Bardakcı & Keser, 2017). Furthermore, the use of ICT in the USA reached 100% in the 1990 (Cuban, 1994). In our country, within the scope of FATIH project, the technological base in schools has been strengthened and it is intended to increase the quality in education. Moreover, the use of ICT has also become popular in foreign language education in recent years. As the mobile technologies developed unprecedently and various social networking platforms have emerged, people of all ages became dependent on technology. If we examine the statistics published by "We are social" (Kemp, 2018) website, we find out that 67% of Turkey's population is the users of the internet, while 51% are active members of social media and 54% use actively social media on mobile devices. It was noted that 98% of people having a cell phone use a smart phone in Turkey. In the light of statistical data provided by the same website, the people in Turkey are active on social media for an average of 2 hours and 48 minutes per day. Again, when the statistical data are examined, it is observed that "WhatsApp" is the most utilized social media communication tool in the world as of June 2018 and roughly 1.5 billion people use it. In light of this data, we can assume that technology is an essential part of our lives and we are using social media almost every day. Since social media becomes an essential part of our lives, it is inevitable to use it in educational environments. Hence, many studies have been conducted on the use of technology inside and outside the school. As in other fields of education, the use of technology and social media is observed in language teaching as well.

The use of WhatsApp as a communication tool is very popular in Turkey. Therefore, the use of such a generally used platform in educational environments and language teaching is inevitable. The researches conducted revealed that the use of WhatsApp in foreign language education has positive effects on the writing (Alsaleem, 2013; Fattah, 2015), reading (Plana, Gimeno, Appel, & Hopkins, 2013), speaking (Manan, 2017) skills and on enriching vocabulary (Alsaleem, 2013; Jafari & Chalak, 2016) (Fattah, 2015) . In addition, it was discovered out that this is influential on the active participation of the students; the students were able to express themselves more comfortably; they had the change to correct their own writing; they experience a better learning experience and it contributed to the positive development of the interaction between student-student and student-teacher outside the school (Fattah, 2015). Also in the literature, it was noted that using WhatsApp encouraged students to read and it helped the students to believe in themselves (Plana, Gimeno, Appel, & Hopkins, 2013; Alshammari, Parkes, & Adlington, 2017). In the study conducted by Şahan, Çoban and Razı (2016) about teaching English idioms through WhatsApp, they have mentioned that the use of WhatsApp was influential in foreign language teaching and there were some positive changes in attitudes and motivations of the students. Furthermore, they have mentioned that the learning became entertaining this way and it is possible to use this method for pronunciation, vocabulary, and writing activities (Şahan, Çoban, & Razı, 2016). Consequently, it has been observed that the use of "WhatsApp" as the social media in language teaching generated positive results. When the literature is reviewed, there is no study that explored the use of social media in secondary education. Furthermore, if we review the studies conducted about the use of WhatsApp in foreign language teaching, we find out that it is influential on vocabulary (Jafari & Chalak, 2016), idioms (Şahan, Çoban, & Razı, 2016) learning, writing (Fattah, 2015) and reading (Plana, Gimeno, Appel, & Hopkins, 2013) skills. On the other hand, in this study, the effects of WhatsApp usage on the affective characteristics of students in English learning were investigated.

Acknowledging the studies conducted before, it is comprehended that almost 2/3 of Turkey's population uses social media (Kemp, 2018). Hence, it is inevitable to use a technology in education since it has been so involved in society. When we examine the researches conducted on social media and education, we find out that there are many studies outside Turkey although there are very few studies conducted in Turkey (Gökmen, Duman, & Horzum, 2016; Şahan, Çoban, & Razı, 2016). Consequently, conducting a study on this topic will considerably contribute to the literature.

Specialists in the field of foreign language education apprehend the problems experienced in Turkey. According to the literature, the sources of the difficulties experienced are based on the following reasons; the fact that the education isn't based on practice, the motivation levels of the students and the attitudes of the students toward the course (Aydın & Zengin, 2008; Baran & Halıcı, 2006; TEPAV, 2014). Thus, the effect of "WhatsApp" as social media on attitudes of the students toward the English course and self-efficacy beliefs of the students will be examined in this study. In this context, this study is considered to contribute to the related literature.

Aim

The aim of this study is to examine the effect of "WhatsApp" on self-efficacy beliefs and attitudes of students in learning English. In this context, the answers to following questions will be sought:

1. What is the effect of using WhatsApp correspondence in English outside of the school on self-efficacy beliefs of students in English?

2. What is the effect of using WhatsApp correspondence in English outside of school on the attitudes of the students toward learning English?

3. What are the opinions of students on the use of WhatsApp correspondence in English outside of school?

Method

Research Model

The aim of this study is to examine the effect of "WhatsApp" on the self-efficacy beliefs and attitudes of students toward English. Thus, an exploratory sequential pattern was used among mixed research methods. In this design, quantitative data are collected, analyzed and then qualitative data are collected. Hence, the quantitative data has been prioritized. Qualitative data is obtained to develop quantitative data. The analysis of data is interconnected and the data are combined in the interpretation and discussion sections (Creswell & Clark, 2011). In order to obtain quantitative data, one group pretest-posttest design was used. In this pattern, the dependent variable is applied to a randomly selected group. Measurements are performed before and after the experiment (Karasar, 2014). Furthermore, a semi-structured questionnaire was applied to receive the opinions of students about WhatsApp. In this structure, the independent variable is the use of "WhatsApp" while the dependent variables are self-efficacy in English and attitude toward English course. In order to measure self-efficacy beliefs and attitudes of students, quantitative data collection processes were applied before and after the experiment. Moreover, qualitative data collection processes were used to support quantitative data. Semi-structured survey questions were used to collect qualitative data. The process of the study is presented in Table 1.

Table 1. *One group pretest-posttest design*

Group	Pretest	Process	Posttest
G	O₁	X	O₂
	-English Self-Efficacy Scale -Attitude toward English Scale (Dependent Variable)	Discussing in English with "WhatsApp" ap-plication that lasted 8 weeks	-English Self-Efficacy Scale -Attitude toward English Scale (Dependent Variable)
G			Conducting semi-structured survey

Study Group

The study was carried out with 19 students attending the 11th grade in an Anatolian High School in the city center of Sivas during the academic year of 2018-2019 and a student studying at another Anatolian high school attending the course program. Demographic data of the study group is presented in Table 2.

20 students in total participated in the study. While 15 of the students that participated in the study are 16 years old, the remaining 5 students are 15 years old. In terms of gender, it is observed that 8 people in the study groups consisted of males while there are 12 females.

In the study, the time spent by the students on the internet, the aim of their using the internet, the time they spent on social networks and social networks they used the most were checked as well. The following information is obtained accordingly.

Table 2. *Demographic Information of the Study Group*

Study Group		f
Gender	Male	8
	Female	12
Age	15	5
	16	15

Table 3. *Social networks used by students*

Social Networks	f
Instagram	11
WhatsApp	7
Ekşi sözlük	1
Twitch	1
Total	20

Table 4. *Time spent by students on the Internet and social networks*

	Time spent with the Internet, phone and computer	f	Time spent on Social Networks	f
	2 hours	1	1 hours	1
	3 hours	10	2 hours	9
	4 hours	1	3 hours	5
	5 hours	2	4 hours	2
	6 hours	2	5 hours	1
	7 hours	1	6 hours	1
	8 hours	2	10 hours	1
	11 hours	1		
Average Time Spent	4.6 hours		3.15 hours	

As it can be apprehended from the tables, the most common social network that students use "Instagram", which followed by "WhatsApp". It is remarked that the students spend an average of 4.6 hours per day with their phone or computer. When the time spent by students on social networks is considered, it is approximately 3 hours and 15 minutes per day. If we examine the purpose of using the internet, we comprehend that 7 of the students use the internet for correspondence, 7 of the students use the internet for watching videos or movies, 2 of them play games, 2 of them read books and 2 of them use the internet for studying and conducting research.

Experiment

The online learning process lasted 8 weeks. This process includes 2 themes from the 10th grade English curriculum. One week of 8 weeks was used for online socialization and for checking the suitability of the technical infrastructure. For 7 weeks, the discussion activities were carried out. In this study, Salmon's (2002) five-stage online learning and teaching framework was used. Figure 1 exhibits this model and the process used in the study.

According to this model, there are five stages in the formation of the online learning environment. These stages are as follows: access and motivation, online socialization, information exchange, knowledge structure, and development. This model essentially focuses on how students will

benefit from online learning environments and how the teacher will follow this process. In the light of this model, "WhatsApp" application, which is a written and oral correspondence platform, has been selected by considering the facility of access. Then, the researcher informed the students during the course to ensure that the students have access to this application and can use the application efficiently. Then a group was created on WhatsApp and the students were asked to participate in this group. The students were generally informed about how to use the platform because they already know how to use "WhatsApp" effectively before the study. Afterward, a welcoming and introducing activity was conducted on platform to ensure that the students socialize. The researcher organized a total of 14 discussion activities each week (2 activities per week) and shared it in the group. The researcher first explained the case in the discussion and then gave some feedback based on the responses of the students. Although the frequency of these feedbacks varies according to the discussion, more feedback has been provided to the students in the first interviews in order to motivate the students, and in the following interviews, the researcher guided the discussion of the students and only intervened for increasing the quality of the discussion. The communications were shared in the form of questions and discussions. The content of these discussions is based on current subjects and values such as love and respect, which are included in secondary education English curriculum, taking into account the 11th-grade achievements of students. These activities were carried out for 8 weeks, one at the weekend and one during the week. The interviews held on weekdays were usually held after 20:00 pm and the weekend meetings were held at any time during the day. When the activity ended, a summary of discussion has been recorded. According to the records, 12,324 words and 58 voicemail messages were used in 14 discussion activities.
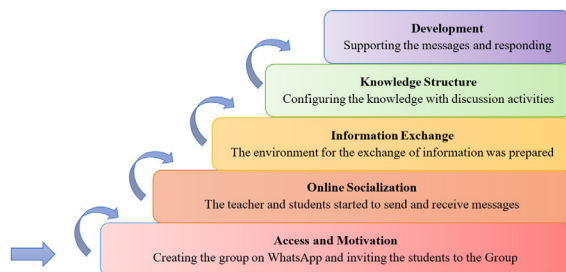

Figure 1. Online learning and teaching framework
(Reference: Salmon, G. (2002). E-tivities: The key to active online learning. London: Kogan Page.K)
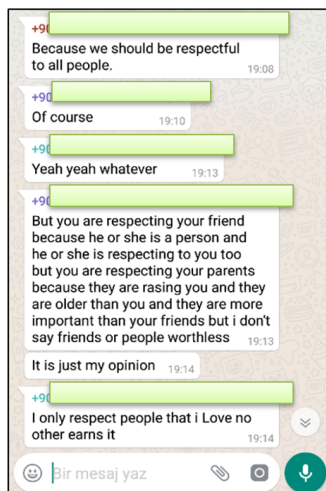

Figure 2. An example of a discussion over WhatsApp

Quality of Online Interaction

The rubric developed by Roblyer and Wiencke (2003) was used to assess the quality of the interaction in distance education. The ability of students and teacher to conduct online discussions was evaluated according to this rubric. A faculty member, working at the Department of Computer Education and Instructional Technology, conducted the evaluation process. There are three levels of interaction in the rubric to define the quality of the interaction. These are low (1-9 points), medium (10-17 points) and high (18-25 points) interaction levels. The level of interaction in this study was found to be 14 points according to the rubric and it was noted that this signifies a moderate interaction (Table 5).

Table 5. *The quality of the online learning environment*

Process	Quality	Points
1. Socialization	Teachers and students introduced themselves in the group and gave short information about themselves.	2
2. Design of Education	Interactions are designed to be between stu-dent-student and teach-er-student.	3
3. Interaction of interac-tion sources	Teachers and students are in two-way asyn-chronous interaction.	2
4. Evidence revealing the student's attachment	Majority of students voluntarily partic-ipated in discussion activities at a rate of 70-75%.	4
5. Evidence revealing the teacher's attachment	The teacher usually answers, influ-ences and directs the opinions of the students within 2-3 hours.	3

Data Collection Tools

Three different data collection tools were applied in the study. These are; "English Self-Efficacy Scale" that test the reliability and validity when applied pretest and posttest and that is developed by Yanar and Bümen (2012); "Attitude toward English Scale" developed by Orakçı (2017). Before using the scales, the authors were contacted by e-mail and necessary permissions were obtained. In addition, semi-structured questionnaire questions were used to get opinions of the students about "WhatsApp".

The "English Self-Efficacy Scale" consists of four sub-dimensions and measures the self-efficacy of the students toward reading, writing, speaking and listening. The scale consists of a total of 34 items in five-point Likert type. The reliability of the scale is .97. The high score obtained from the scale was admitted as an indicator of high self-efficacy belief in English. In this study, Cronbach's Alpha reliability coefficient was calculated andfound to be .94.

The English attitude scale consists of 16 items answered in five-point Likert-type. While the highest score of the scale is 80, the lowest score is 16. The scale has two sub-dimensions: affective and behavioral. The highest score that can be obtained for the affective sub-dimension is 50, and the lowest possible score is 10. The highest score for behavioral sub-dimension is 30, and the lowest possible score is 6. The reliability of the scale is .89. In this study, Cronbach's Alpha reliability coefficient was calculated andfound to be .88. The high score obtained from the scale indicates a positive attitude toward the English course.

In this study, a semi-structured questionnaire was applied to collect qualitative data as well. This method, which is a great method(Yıldırım & Şimşek, 2013) for revealing people's emotions, thoughts, perspectives, thoughts, and

experiences, is a process that has been carried out during and after the 8-week study on "WhatsApp", a social media tool and it is used for obtaining in-depth knowledge about the experiences, emotions, and thoughts of the students as well as their self-efficacy beliefs and attitudes toward English. Hence, a literature review on English self-efficacy and attitudes toward English course was conducted. At the end of the literature review, four sub-dimensions of the self-efficacy perception in English were determined. These sub-dimensions are self-efficacy beliefs for reading, writing, listening and speaking. Furthermore, studies on attitudes toward English courses were evaluated and a questionnaire was prepared. First, an evaluation form has been prepared for asking the opinions of the experts and the opinions of 1 Professor Dr., 2 Associate Professors and 2 Academicians were asked about the questionnaire in terms of the content, scope and purpose. In line with the feedback from the experts, the form was corrected accordingly, and it was submitted to the experts again and this process was repeated three times until we have reached a final agreement on the questionnaire. There are 7 questions and 14 inquiry questions in the questionnaire. After preparing the semi-structured questionnaire, the questionnaire was applied to two students, who do not participate in the experiment. In order to prove similarity in terms of age and level with the students in the study, particularly students studying at 11th grades were selected. In this practice, the clarity of the questions and the time spent on each question were tried to be determined. In the pilot application, students were asked to share their thoughts and suggestions about the questions. Necessary corrections have been made considering the opinions of the students about the clarity of the questions and the time spent on each question. It was noticed that there was no problem in the comprehensibility of any item. Hence, the questionnaire was finalized.

Data Collection

Data in the study were obtained by quantitative and qualitative data collection processes. For this purpose, first, the Attitude toward English Scale and English Self-Efficacy Scale were used before the application. After eight weeks of implementation, these two scales were applied to the students and the related data were collected. During the implementation of the two scales, students were asked to respond to the questions honestly. In addition, the scales were conducted on different days so that the students respond sincerely.

In the study, the qualitative data were collected from students participating in "WhatsApp" implementation for 8 weeks through a semi-structured questionnaire. The semi-structured questionnaire was implemented on a voluntary basis at the end of the 8-week application. 20 students participated in the study and 19 of these students volunteered to complete the questionnaire. Only 1 student did not want to fill the questionnaire. Hence, data were obtained from a total of 19 students.

Analysis of Data

The attitudes and self-efficacy of the students toward the English course were measured before and after the application. The "dependent" t-test was performed to examine if there was a significant difference between pretest and posttest. The dependent t-test compares the means (obtained at different times) of two related groups to determine whether there is a statistically significant difference between these means (Can, 2017).

An inductive method was preferred in the analysis of qualitative data. Because the themes and codes were not distinguished before the study. First, qualitative data were written. Then the researcher and the two program development experts have thoroughly read, examined and identified the themes and codes. The interviews were repeated three times until the researchers agreed on the themes and codes, and so, the themes and codes were finalized. In order to increase the reliability, the agreement percentage about the coding of the three researchers was calculated by using the following formula: "Reliability = Consensus/(Consensus+Disagreement) x 100" and the agreement percentage was determined to be .76. Finally, 7 themes and 12 codes have been identified.

Findings

Findings from Quantitative Data

Dependent (associated) t-test was used to examine whether the use of WhatsApp has an impact on English self-efficacy perceptions and attitudes toward English course. Before the t-test was performed, the extreme values were examined with Box-Plot and it was determined that one data was found to be extreme for self-efficacy belief in writing. The respective extreme data was removed from the data set and then the normal distribution characteristics of the difference between the pre-test and post-test scores were examined using skewness and kurtosis, Shapiro-Wilk test and Quantile-Quantile plots (Q-Q plots). First, the skewness and kurtosis coefficients of the data were analyzed. The related results are presented in Table 5.

Table 6. *Skewness and kurtosis coefficients of difference points*

	Skewness coefficients	Kurtosis coefficients
The self-efficacy average points for English reading	.64	-.04
The self-efficacy average points of English writing	.81	1.02
The self-efficacy average points of English listening	.93	.96
The self-efficacy average points of English speaking	.24	.27
Average points for attitude toward English course	.29	-.57

The skewness values of the data set ranged from .24 to .93 while the kurtosis values ranged between -.57 and 1.02. Can (2017) ascertained that if the skewness and kurtosis values are between +1.96 and -1.96, this signifies an indicator of the normal distribution. Hence, the data obtained show that the data is distributed normally.

Another test conducted for assessing the normality is the Shapiro-Wilk test. Shapiro-Wilk test was recommended for normality testing when the data set consists of less than 30 participants (Can, 2017). In this study, this test was performed because the data set is 20. The results are presented in Table 7.

Table 7. *Shapiro-Wilk test results of the difference scores*

	Shapiro-Wilk (p)
The self-efficacy average points for English reading	.47*
The self-efficacy average points of English writing	.32*
The self-efficacy average points of English listening	.09*
The self-efficacy average points of English speaking	.54*
Average points for attitude toward English course	.73*

*p> .05

Table 8. *t-test results on the effect of using WhatsApp on English self-efficacy and attitude toward English course*

	Measurement	*N*	*M*	*S*	*sd*	*t*	*p*	Effect *(d)*
Self-efficacy belief for reading English	Pretest	20	3.41	.77	19	2.99	.007*	.69
	Posttest	20	4.02	.56				
Self-efficacy belief for writing in English	Pretest	19	3.18	.63	18	.910	.374	.26
	Posttest	19	3.33	.67				
Self-efficacy belief for listening English	Pretest	20	3.46	.78	19	2.166	.043*	.49
	Posttest	20	3.96	.69				
Self-efficacy belief for speaking English	Pretest	20	3.44	.94	19	1.418	.172	.32
	Posttest	20	3.86	.76				
Attitude toward Eng-lish course	Pretest	20	3.36	.38	19	7,223	.000*	1.64
	Posttest	20	4.26	.37				

*p> .05

Therefore, all the values were found to be greater than .05. If the *p* value is greater than .05, it means that the data is normally distributed (Can, 2017).

Furthermore, the Q-Q Plot was considered to examine the normal distribution of data. At the end of Q-Q Plot, the theoretical values of the real value were overlaid and the angle was close to 45 degrees. This also reveals that the data is normally distributed.

As the normality conditions of the data sets were met, the dependent t-test was performed. The results are given in Table 8.

At the end of the research, a statistically meaningful difference was observed as the effect of WhatsApp usage on the self-efficacy beliefs of students for reading in English, *t*(19)= -2.99, *p*< .05. While the average of self-efficacy beliefs of the students for reading English was 3.41 before the application, it has been increased to 4.02 after the WhatsApp application. As the effect size value is .69, this exhibits a moderate effect (Taşpınar, 2017). These findings confirm that the use of WhatsApp in the group outside the school has a significant effect on self-efficacy beliefs of the students.

At the end of the research, a statistically meaningful difference was not perceived as the effect of WhatsApp usage on the self-efficacy beliefs of students for writing in English, *t*(18)= -.912, *p*> .05. While the average of self-efficacy beliefs of the students for writing in English was 3.18 before the application, it has been increased to 3.33 after the WhatsApp application. However, this increase is not statistically meaningful. As the effect size value is .26, this indicates a low level of impact (Taşpınar, 2017).

At the end of the research, a statistically meaningful difference was observed as the effect of WhatsApp usage on the self-efficacy beliefs of students for listening English, *t*(19)=-2.166, *p*< .05. While the average of self-efficacy beliefs of the students for reading English was 3.46 before the application, it has been increased to 3.96 after the WhatsApp application. This finding proves that the use of WhatsApp is significantly effective in self-efficacy beliefs of the students. As the effect size value is .49, this exhibits a moderate effect (Taşpınar, 2017).

When the findings of the study were examined, it was seen that using WhatsApp outside of school on students' speaking skills had no statistically significant effect, *t*(19)= -1.418, *p*> .05. The average of self-efficacy beliefs of the students for speaking in English has been increased from 3.44 to 3.86. As the effect size value is .32, this indicates a low level of impact(Taşpınar, 2017). Although this increase is statistically meaningful, it can be assumed that there is a positive increase after the application.

At the end of the research, a statistically meaningful difference was observed in the attitudes of students toward English course after the WhatsApp application, *t*(19)= -7.223, *p*< .05. While the average of attitudes of the students toward English was 3.36 before the application, it has been increased to 4.26 after the WhatsApp application. The effect size value of 1.64 indicates a high level of effect (Taşpınar, 2017). This finding reveals that using WhatsApp outside the school in this group has a significant effect on the attitudes of the students toward English course.

Findings from Qualitative Data

In this study, which was conducted to examine the effect of communicating in English using WhatsApp on the self-efficacy beliefs of students for English and their attitudes toward English course outside the school, the application lasted 8 weeks and after the application, a semi-structured questionnaire was applied to the students. At the end of the survey, content analysis was performed and the following themes and codes were obtained.

Table 9. *Theme and codes obtained from qualitative data*

Themes	Codes	f
Self-efficacy belief for listening English	Positive self-efficacy belief	19
	Negative self-efficacy belief	4
Self-efficacy belief for speaking English	Positive self-efficacy belief	6
	Negative self-efficacy belief	44
Self-efficacy belief for reading English	Positive self-efficacy belief	6
	Negative self-efficacy belief	47
Self-efficacy belief for writing in Eng-lish	Positive self-efficacy belief	7
	Negative self-efficacy belief	33
Attitudes toward English	Characteristics of positive attitude	23
	Characteristics of negative attitude	1
Emotions experienced	Happiness	16
	Excitement	11
	Joy	3
	Relief	3
	Curiosity	3
	Sadness	3
Problems experienced during the process		5
Total		234

At the end of the study, it is observed that there are positive developments in the self-efficacy beliefs of the students about listening to English in light of the data obtained from semi-structured questionnaires. When students were questioned about their beliefs about listening, a majority of the students declared that there were positive developments in this regard. The expressions of the students mentioned below are the examples:

> S3_(male): I think I can understand now when I listen to something in English.

> S9_(Female): I think I can understand effortlessly the things I hear.

> S18_(male): Sometimes I have difficulty in understanding. But this only concerns me. I know I can understand better if I work a little more.

> S12_(Female): I understand better now in comparison to last year. Because my vocabulary has been developed and we've implemented many listening activities.

At the end of the study, few students stated that there was no positive development in self-efficacy beliefs about listening. For example;

> S16_(Female): My listening skills weren't developed. They are still undeveloped. I didn't experience a change.

> S17_(male): I do not trust myself about this issue.

The majority of the students stated that this study has a positive effect on the self-efficacy beliefs and their self-confidence has been increased and they feel more competent in this regard. Very few students stated that they did not experience any changes. Some opinions of the students are presented below.

> S7_(male): When I speak, I remember the activities we have carried out and I make better sentences. I think I can do it now.

> S15_(male): Before, I was afraid of making mistakes, but now I can speak more freely. I'll do it. Now, I trust myself.

> S17_(male): I trust myself, but my speaking skill changes based on the topic.

> S2_(Female): I believe that this practice has helped to develop my skills a little because I think about a given subject and express what I think as I wish.

> S3_(male): I feel more sufficient in speaking English after this application.

> S18_(male): I recall the patterns and words that my friends and teacher use in WhatsApp. When I speak, I can remember these patterns and words.

> S8_(Female): I did not talk too much, I was afraid to make mistakes when forming a sentence, but I have more faith in myself and I am not afraid of making mistakes. I try to express myself effortlessly.

At the end of the survey, students declared that they experienced a positive increase in self-efficacy beliefs about reading, they had more confidence in themselves in this regard. Some opinions of the students are presented below.

> S17(male): I could not understand when I watched a series with English subtitles before but I feel confident that I can understand the things I read in the group or elsewhere.

> S18_(Female): I do not feel like "I cannot do it, I cannot understand" anymore. In fact, I realized that I could not achieve anything if I do not work hard.

> S13_(Female): I do not have difficulty in understanding, I can take a look and understand the subject, theme, content.

> S8_(Female): I was very slow on reading. I could not advance quickly. Even I didn't want to read as I was too afraid of making mistakes. This application contributed a lot to me. We both have fun and learn.

> S16_(Female): I didn't understand a thing when I was reading before, now at least, I can tell what is the subject about. I think I can do it.

> S15_(male): I trust myself, I'm not afraid, even if I make a mistake, I correct it and I express it again. Only I do not understand if there are so many words that I do not know.

> S1_(male): I trust myself and I know I can do it. I completely believe in myself.

From the qualitative data obtained, it is comprehended that very few students declared there is no change in the self-efficacy belief of the students for reading in English. The opinions of the students are given as an example.

> S7_(male): There has not been a significant improvement in my reading skills. I am not sure.

> S13_(Female): I didn't experience any change.

> S17_(male): Fifty-fifty. Because when there are many prepositions and the conjunctions, you do not feel that confident.

When the change in the self-efficacy beliefs of students about English writing skill is examined, it is asserted that a large part of the students commonly believe that these activities increase their beliefs and that they believe they can do achieve more now. There are very few students who say they didn't experience any change in this direction. The opinions of the students are presented below.

> S1_(male): I stopped thinking about a sentence many times, and I write whatever I have in mind. Then, I realized that I started to make better sentences and I was understood.

> S4_(female): If we continue to use this study method, I think that I can easily reach the writing level that I want to have in both social media and in class.

> S9_(female): I'm feeling better and I believe I will be much better.

> S13_(female): I think I am more skilled in writing than the other areas. I have the right to correct, change or develop my opinion at any time. And I can write. I believe in myself. I also learn new ideas and conjunctions by talking about the application and this contributes more to my writing.

> S3_(female): A positive change occurred to me when we started to use this application, I feel like I can write something new from scratch.

> S5_(female): After the application, I observed the sentences of other people and compared them with my own sentences, and I discovered my mistakes. Hence, I started to build stronger sentences.

> S14_(female): I learned where and how to use the prepositions and the conjunctions and literally my self-confidence has been increased.

Within the scope of the research, students were asked questions about their attitudes toward English and in the end, it has been revealed that a large part of the students developed positive attitudes. Some opinions of the students are presented below.

> S1_(male): After this application, I realized that English is not something to be afraid of, that I can easily speak and communicate with other persons using English. For me, the lessons used to be boring in the past, and now I am looking forward to the English lesson.

> S2_(female): Truly, I think about the topic given in the group even I am not very involved in the discussion, and I realized that I can make the sentences instantly.

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S3(male): I think that it is not difficult to use English in our daily lives and that it is delightful to achieve this. At the end of the application, my motivation for the English course considerably increased.

S4(female): I started to like it more. I started to like English more.

S5(female): Although I used to like English in the past, I could not completely concentrate on the course, but right now, my judgment has been changed and it is more efficient now.

S7(male): Since it was not an application we are accustomed to, it was interesting for was and I feel more committed to the English course for the time being.

At the end of the research, it has been ascertained that the students developed positive emotions and experienced emotions such as excitement, pride, happiness, curiosity, and relief. The opinions of the students about the emotions experienced by the students are presented below.

S7(male): When I translate something, as I write about a topic or when I read something, I am happy to feel that I have accomplished something.

S10(female): I feel excited since I learnt new things.

S11(male): I feel comfortable and I'm learning English by having fun, I do not get bored.

S18(female): I am proud of myself. And I am ambitious to achieve more.

S2(female): I feel that I am advancing day by day and I am both curious and enjoying myself.

S5(female): Suddenly, I am getting involved in the subject. I can comment, write about it and I can understand. This motivates me and makes me happy at the same time.

Within the scope of the research, students were invited to express the problems they have experienced during this application. In this context, students mentioned that sometimes they had connection problems, they could not keep up with the speed of the conversation on WhatsApp, sometimes they didn't have access to the Internet and sometimes they got bored because of the topics that have been discussed. The opinions of the students about this situation are presented below.

S19(male): There was an activity I could not join since I didn't have access to the Internet. This is frustrating.

S15(male): I am not very active in the conversation and sometimes the topics are boring. Some of my friends do not have a cell phone or they do not have time.

S8(female): I am too slow to follow the conversation. I can't write so fast and get things together.

S10(female): Sometimes there are problems and the screen freezes.

Discussion

This study examines the effect of "WhatsApp" usage on the attitudes of students toward English self-efficacy and English course in English language education outside the school. Hence, an application that lasts 8 weeks was implemented and the quantitative and qualitative processes were used to examine the effects of this application. At the end of the research, a statistically meaningful difference was observed as the effect of WhatsApp usage on the self-efficacy beliefs of students for reading in English. The data obtained from the separate qualitative process prove this argument as well. At the end of the survey, students declared that they experienced a positive increase in self-efficacy beliefs about reading, they had more confidence in themselves, in this regard, when they are

reading a text in English. When we review the literature, it was comprehended that using WhatsApp has a positive effect on the reading of English (Plana, Gimeno, Appel, & Hopkins, 2013). Also in the literature, it was apprehended that using WhatsApp encouraged students to read and it helped the students to believe in themselves (Plana, Gimeno, Appel, & Hopkins, 2013; Alshammari, Parkes, & Adlington, 2017). The findings obtained correspond to the studies mentioned in the literature.

At the end of the research, it was noted that a statistically meaningful difference wasn't perceived as the effect of WhatsApp usage on the self-efficacy beliefs of students for writing in English However, although there was no meaningful difference according to the results of the study, it was witnessed that there was an increase in the average scores on the pretest and posttest results. Furthermore, information obtained from qualitative processes confirms this finding. According to the semi-structured questionnaire, the students stated that they could now express their feelings and thoughts by making sentences, they feel better, their confidence to write any text has been increased and they also believe that they could write more easily. When we examine the literature, Fattah (2015) declared that the WhatsApp application has a positive effect on the writing skills of the students. Considering the significance of vocabulary knowledge in order to communicate effectively in the target language, it is apprehended from the literature that the use of WhatsApp has a positive effect in this regard as well (Alsaleem, 2013; Jafari & Chalak, 2016). In the literature review, no studies have been observed on the self-efficacy belief in writing.

The results of the research reveal that using WhatsApp in English outside the course has a statistically meaningful effect on self-efficacy beliefs of the students. The data obtained from qualitative means also confirm this as well. The students asserted that they thought they could understand any text they are listening to at the end of the study and that they experienced an improvement in their skills compared to the previous years and that they feel more confident about it. When the literature is analyzed, no study has been discovered on the self-efficacy belief for listening in English.

At the end of the research, it was remarked that a statistically meaningful difference wasn't perceived as the effect of WhatsApp usage on the self-efficacy beliefs of students for writing in English. However, there is an apparent increase in the averages of pretest and posttest. According to the results obtained from the qualitative data, it was witnessed that the practice created a positive effect on the speaking skills of the students. Indeed, the majority of the students stated that this study has a positive effect on the self-efficacy beliefs and their self-confidence has been increased and they feel more competent in this regard. Manan (2017) asserted that the use of WhatsApp for foreign language education is effective since it allows the students to develop the communication skills in the target language, also, their speaking skills are being developed in the meantime. In the literature review, no studies have been found on the self-efficacy belief in speaking.

At the end of the study, the attitudes of the students toward English were analyzed and it was understood that using WhatsApp in English had a meaningful effect on attitude toward English. The data obtained from qualitative means also prove this as well. The students stated that they are no longer afraid of English, they feel confident in themselves, they are more willing to learn and they start to enjoy the lesson even more. In the literature review also, the use of WhatsApp was determined to be effective in developing positive attitudes of students toward the

courses (Manan, 2017) . In the study conducted by Şahan, Çoban and Razı (2016) about teaching English idioms through WhatsApp, they have mentioned that the use of WhatsApp was influential in foreign language teaching and there were some positive changes in attitudes and motivations of the students. Likewise, Fattah (2015) has proved that this application has positive effects on students, allows students to express themselves more comfortably, and develop positive thoughts about the language.

At the end of the research, the emotions of the students about WhatsApp were considered in the qualitative process and it was ascertained that students usually experienced positive emotions such as happiness, excitement, pride, curiosity, and relief. When the literature about the effects of WhatsApp usage on the emotions experienced by the students is reviewed, similar results have been collected and it has been remarked that the students feel more comfortable and have the opportunity to learn in a comfortable environment (Fattah, 2015; Manan, 2017). Pekrun, Goetz and Perry (2002) declared that emotions have an important impact on both the learning process and the learning outcomes. Control-value theory asserts that positive or negative feelings experienced in learning environments are indicators for predicting the academic achievements of the students (Pekrun, 2006). In this study, it is apprehended that the positive emotions experienced are an indicator for the students even though the academic success of the students is not taken into consideration.

At the result of the research, it is noted that some problems are encountered during the study from the data obtained from the qualitative processes. In general, the problems can be listed as follows; technical problems, the fact that the students do not find the topic interesting, the fact that the student cannot keep up with the speed of the friends in the group.

Conclusions and Recommendations

The purpose of this study is to investigate the effects of the use of WhatsApp in English on English self-efficacy beliefs and attitudes and thus to contribute to the literature on the use of social media in English education. In this context, the following results are obtained:

• The use of WhatsApp in English outside the school has a positive effect on reading, writing, speaking and listening self-efficacy beliefs of the students.

• Furthermore, the use of WhatsApp in English outside the school has a positive effect on attitudes of the students toward English course.

• Students experienced positive emotions such as happiness, joy, pride, relief, and excitement during the application.

• It was mentioned that the opinions of the students about the use of the practice were positive and they supported the use of this application for learning English.

Thus, the following recommendations can be presented according to the data obtained at the end of the study:

•WhatsApp in English outside the school can be used to improve positive attitudes of the students toward the English course.

• WhatsApp in English outside the school can be used to improve self-efficacy belief of the students in English.

• The research was conducted for the English course and the effectiveness of the system in several courses may be examined in prospective studies.

• WhatsApp is used as a social media tool in this research. In future research, diverse social media tools can be used and the results of the researches can be compared

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The Investigation of the Relationship Between Mathematics and Science Literacy and Information and Communication Technology Variables

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Abstract

This study attempted to identify the information and communication technology items that affected students' mathematics and science literacy scores by making use of the 2015 PISA data, The presence of numerous items related to ICT in the PISA and the administration of these items to large groups of people provides researchers with a large data source. However, researchers experience challenges in revealing the significant and beneficial data among the entire data set. So one of the most commonly used data mining method is the Chi-squared Automatic Interaction Detection method (CHAID), which is the decision tree method. As a result of the CHAID analysis, conducted to reveal the ICT items related to mathematics literacy scores, it was revealed that there was a significant relationship between mathematics literacy scores and the eight variables. For science literacy, there was a ten significant relationship variables. There is a relationship between high science and mathematics literacy scores and using digital devices at an early age as well as feeling comfortable with using digital devices at home. As an outcome of the CHAID algorithm, the realization of a significant reduction was achieved in the dimensionality of both models. The selected variables can be used for future research and development of new, parametric models. In the resulting model, apart from the reduction of the number of predictors, the reduction of their categories was also achieved.

Keywords: Information and Communication Technology, Data Mining, Chaid, Mathematic Literacy, Sciene Literacy

Introduction

Information and communication technology (ICT) plays a significant role in all spheres of life, including the field of education, where these kinds of resources have gained increasing importance because educational developments should reflect individuals' needs, expectations and interests. Only this kind of a development can make best use of ICT to increase the quality of teaching and learning, share knowledge and information, provide a high degree of flexibility to respond to the needs of the society, decrease the cost of education, and increase internal and external productivity (UNESCO, 2005). The current world is becoming an information society; thus, making developments to facilitate access to information and raising individuals who know how to access information to solve the problems they encounter are among the priorities of societies. Hence, ICT is integrated into learning and teaching environments to develop students' 21st century skills (Kim, Kil, & Shin, 2014).

ICT is defined as a "diverse set of technological tools and resources used to communicate and to create, disseminate, store, and manage information" (Blurton, 1999). It is rather important to understand how ICT is utilized in educational contexts, what educational goals it caters to, and what role it plays in the success of learning processes (Papanastasiou, Zembylas, & Vrasidas, 2005). ICT directs educational policies in societies that do not want to fall behind the information age. Numerous countries have enforced policies regarding the use of ICT and made significant investments in resources for the ICT infrastructure of schools (Witte & Rogge, 2014). Moreover, many research studies in various countries have focused on ICT, which has an important place in educational policies, and thus, made substantial contributions to the related literature.

Du, Harvard, Sansing and Yu (2004) reported that the presence of a computer in students' homes and the frequent use of the computer by the students had a positive impact on the achievement scores of reading and math, which were derived from the 2002 Educational Longitudinal Study database. In another study, conducted by Banerjee, Cole, Duflo, and Linden (2004), a computer assisted learning program was designed and implemented to investigate the impact of this program on students' achievement in mathematics. As a result of the two-year-long investigation of the computer assisted learning program, it was revealed that the level of students' achievement in mathematics had increased in both years, with higher achievement levels in the second year. Hence, the study yielded the finding that the implementation of computer assisted learning had a significantly positive impact on students' achievements in mathematics. Similarly, Kim and Chang (2010) stated that access to a home computer and the use of computers for various purposes had a positive impact on students' achievements in mathematics. In another study, carried out by Valentine, Marsh, and Pattie (2005) reported that the use of ICT within the home had a statistically significant effect on students' levels of achievement in English and mathematics.

In a meta analysis by Torgerson and Zhu (2003), it was maintained that the use of ICT had a positive, but small degree of impact on student performance. There are other studies in the literature reporting the positive effect of ICT on student learning (Balanskat & Blamire, 2007; Carrasco & Torrecilla, 2012; Eng, 2005). Harrison et al., (2002) investigated the achievement of students by analyzing data obtained from ImpaCT2, a large-scale national survey in the United Kingdom. While the study yielded significant results for the five-year-old group of students' achievement in English, the results for the 8- or 10-year-old student group were found to be insignificant. However, it was reported that there was a positive relationship between ICT and student achievement in mathematics. Thus, it can be concluded that there there is a significant relationship between ICT and academic performance of students.

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The increase in interest towards the use of ICT in large-scale international assessments in recent years has also led to an increase in the number of studies in this area. Studies conducted by the Trends in International Mathematics and Science Study (TIMSS) and the Programme for International Student Assessment (PISA) include questions related to the use of ICT. Since PISA and TIMSS provide a large source of data on ICT, they have become the most commonly used data for researchers who want to want to conduct research on ICT. PISA, pursued by the Organization for Economic Cooperation and Development (OECD), is an international study measuring 15-year-old students' reading, mathematics and science literacies. Since the year 2000, PISA has included various questions regarding the use of ICT, including questions about the access to technical tools and devices, the frequency of using them, and self-efficacy beliefs. Hence, the number of ICT studies making use of data from PISA is considerably high. According to the 2003 PISA results, it was revealed that students who made regular use of the computer had a higher level of achievement in the core academic subjects (OECD, 2006). Similarly, using the 2000 PISA data of the U.S.A., Papanastasiou and Ferdig (2006) revealed that using the computer at home had a positive impact on achievement in mathematics. Based on the results of the 2009 PISA, Lee and Wu (2012) reported that the presence of ICT equiment within the home environment contributes to the development of students' reading and writing skills. Furthermore, in a study where data from large-scale exams of various countries were used, Skryabin, J. Zhang, Liu and D. Zhang (2015) investigated how the development level in ICT and individual use of ICT affected 4th and 8th grade students' achievements in reading, mathematics and science. Based on the results of the study, it was determined that development level in ICT was a significant, positive predictor of students' individual academic performance. Similarly, by conducting a study based on the 2000 PISA data, Fuchs and Woessmann (2005) revealed that there was a positive relationship between achievement and access to a computer both at home and at school. However, when the variables of family background and school characteristics were controlled, a negative relationship was found between achievement in mathematics and having access to a computer in the home environment, and no relationship was found between achievement in mathematics and having access to a computer in the school environment. They found that computers within the home environment had a positive impact only for certain purposes (e.g. e-mail and web pages). Similarly, Wittwer and Senkbeil (2007), who examined the 2003 PISA data of German students, reported in their study that there was no association between students' access to a computer in the home environment and their mathematics performance.

When these previous studies in the literature were examined, it was observed that the impact of ICT on learning outcomes was positive and significant at a moderate degree, while findings yielded by studies on the relationship between use of BIT and student performance were more complicated (Skryabin et. al, 2015). Issues related to the impact of ICT on educational processes, such as communication, learning and lifestyle are still being discussed by means of studies conducted in the related literature. Whether or not ICT really supports and develops learning and increases the quality of education were investigated through these discussions. Thus, by making use of the 2015 PISA data, the present study attempted to identify the information and communication technology items that affected students' mathematics and science literacy scores. The presence of numerous items related to ICT in the PISA and the administration of these items to large groups of people provides researchers with a large data source. However, researchers experience challenges in

revealing the significant and beneficial data among the entire data set. One of the methods resorted to in order to overcome this challenge is data mining (DM). DM aims to analyze the data obtained through various means to transform them into a comprehensible structure. DM has been developed as a multidisciplinary approach by which abundant data can be analyzed rapidly and defines the important models disguised in the data set (Milanović & Stamenković, 2016). Even though there are numerous methods in data mining, one of the most commonly used methods is the Chi-squared Automatic Interaction Detection method (CHAID), which is the decision tree method. CHAID, which enables the independent variables related to the dependent variables and the related data to be revealed as much as possible, categorizes the data set into more homogenous subgroups. Pursuing the study by categorizing the the whole into its components and categorized probable subgroups can lay a more realistic foundation for researchers and in this way the assumption of homogeneity, which is considered important in statistics, is secured (Kadri & Boysan, 2007). Moreover, this method enables the inclusion of both continuous and categorical data at the same time. What's more, it facilitates the interpretations of the results as it provides a visual presentation of the relationships between CHAID and dependent and independent variables. The first phase of the tree, formed as a result of the CHAID analysis, begins with the division of a starting independent variable into dependent variables as categories or value intervals displaying statistically significant differences. This categorization continues until significant variables can no longer be calculated statistically. The chi-square test is used for categorizations in which the dependent variable is categorical, while in situations where the dependent variable is continuous, the algorithm utilizes the F test (Rokach & Maimon, 2008).

Method

The present study, which aimed to examine the ICT factors related to students' mathematics and science literacy scores by means of CHAID analysis, adopted the survey method. In this study, secondary analyzes were made by using PISA data and the current situation was tried to be revealed.

Sample of the Study

The data sources for this research include the PISA 2015 datasets. The data of 35 OECD countries were used in the study. Data from a total of 248 620 individuals from these 35 countries were collected. However, since the "Information and Communication Technologies Survey" was not done by four OECD countries, based on their own preference, (Canada, Norway, Turkey, the United States), 5000 cases were selected randomly from among the dataset of 208 388 cases from the remaining 31 countries. After data cleaning and the exclusion of missing data, the final sample contained 2307 cases in the PISA 2015 dataset.

Data Collection Instruments

As data collection tools in the study, the ICT Familiarity Questionnaire used in the 2015 PISA and the Scientific and Mathematical literacy tests were utilized.

Information and Communication Technology Familiarity Questionnaire. ICT Familiarity Questionnaire (ICQ) is an 81-item questionnaire administered to students based on countries' preferences. After the student questionnaires were completed, they were administered ICQ, which took 10 minutes to complete. These 81 items were selected as the independent variables of the study.

Scientific and Mathematical Literacy Tests. In PISA, students are administered three different tests, namely reading, science literacy and mathematics literacy tests. In each administration, one of the three areas is chosen to be primary, so fewer items are included from the other two areas. The primary area in PISA 2015 was science literacy. In 72 countries where PISA 2015 was administered, these tests were administered via either computer-based assessment (57 countries) or pen and paper based assessment (15 countries). For the computer based assessment, 66 different booklets, and for the pen and paper based assessment, 30 different booklets were formed. Each booklet consisted of four sections, each lasting 30 minutes (Taş, Arıcı, Ozarkan, & Özgürlük, 2016). The PISA 2015 administration consisted of two sittings, each given 60 minutes, and there was a 5-10-minute break between the two sittings. Approximately 65 percent of the science items were multiple-choice and 35 percent of them were open-ended questions. Of the mathematics items, approximately 40 percent were multiple choice and 60 percent were open-ended items (Kastberg, Chan, & Murray, 2016). However, students do not answer all the questions in the PISA. Predictions of students' unobserved responses aremade based on students' observed responses and thus 10 different probable values are predicted (plausible values-PVs). In the PISA 2015 data file, the predicted values for mathematics literacy were named as PV1MATH-PV10MATH, while those for science literacy were named as PV1SCIE-PV10SCIE. As the correlations among the 10 different PVs for mathematics and science were considerably high (.85 and above), for both domains, PV1s were selected as dependent variables.

Data Analysis

Detailed information related to the variables used in the current study is presented in Table 1 in the Appendix. The CHAID decision tree method, one of the multivariate analysis methods, was used in order to identify which independent variables were highly related with which dependent variables and to examine the dominance among these variables. As the depedent variables used in the present study were continuous, the CHAID algorithm F test was used to identify the factors related with dependent variables and at which level of these factors there were strong relationships.

In the alogrithm used, CHAID, as method becoming increasingly common, was utilized, Y_1 and Y_2 were used separately as dependent variables, $X_1, X_2, X_3,..., X_{81}$ were used as independent variables (see Table 1), cross-validation was used as a method of validation, and specifications were set as follows: maximum tree depth:3, minimum cases in parent node:40, minimum cases in child node:15. The level of significance was set as α=0.05 for node splitting. Whether or not the variables were appropriate for splitting was decided on by utilizing the Bonferroni corrected p value. In addition, during the process of model construction, the ten-fold cross-validation model was performed.
Findings

Upon the examination of the decision tree derived from the CHAID analysis, in which the mathematics literacy scores were the dependent variable and a total of 81 variables in the ICT Familiarity Questionnaire were the dependent variables, it was observed that the model consisted of three depths and total of 23 nodes, of which 12 were terminal. In addition, from a total of 81 initially specified independent variables, the final model included eight, while the remaining 73 were not statistically significant from in terms of their association with the score of mathematical literacy. As can be observed in Figure 1, students' average

score in mathematics literacy and the standard deviation was found to be 512.94 and 89.118, respectively. Based on this average, it can be concluded that the mathematics literacy of the students constituting the sample of the study corresponds to level 3.

The variable with the highest F value among the independent variables having a statistically significant relationship between the dependent variables has first place in the decision tree that was formed. In the present study, the independent variable having the highest relationship with mathematics literacy scores was found to be the variable coded as X_{19} ($F_{(2, 2304)}= 84.844$, $p< .001$). This finding demonstrates that X_{19} is the independent variable that has the strongest relationship with the dependent variable and has the greatest strength in the splitting of the nodes into sub-nodes. As a result of this analysis based on the mathematics literacy scores, 2307 participants were split into three sub-nodes, which included different categories of the X_{19} variable, which is related to whether or not there were ebook readers in the school for students to read. For X_{19} within the first level of the tree, nodes 1, 2 and 3 are parent nodes. It was revealed that the highest mathematics literacy score mean belonged to the students who did not have e-book readers to use in their schools (node 1), while the lowest mathematics literacy score average belonged to the students who did have the e-book reader to use and who reported to be using this device (node 3).

The split of node 2 is based on X_{27} ($F_{(1, 148)}=13.190$, $p< .01$), producing the following two groups: node 7 and node 8, which contain less than or equal to 31-60 minutes per day and more than 31-60 minutes per day, respectively. When nodes 7 and 8 are examined, it can be observed that students whose duration of Internet use was longer had higher mathematics literacy score average. The split of node 3 is based on X_{62} ($F_{(1, 238)}= 14.268$, $p< .01$), producing the following two groups: those stating disagreement or strongly disagreement (node 9), and those stating agreement or strongly agreement (node10). The average mathematics literacy score of the students who agreed that the Internet is a great source for the topic of interest was found to be higher when compared to those who expressed disagreement. Regarding this tree level, for X_{45} nodes 4, 5 and 6 are parent nodes, and for X_{27} node 7 is terminal, while node 8 is parental and for X_{62} node 9 is terminal, while node 10 is parental.

In the third level of the tree depth, the variable that is statistically significant for splitting node 4 is the frequencies of students' downloading/uploading/browsing the school website out of school, X_{46} ($F_{(1, 1415)}= 68.255$, $p< .001$). These nodes are node 11, which consisted of students who never or hardly ever downloaded/uploaded/browsed the school website out of school boundaries, and node 12 which comprised students who did so. Of the mathematics literacy scores in each of these two nodes, those that belonged to the students who used the school website were observed to be higher. The variable that is statistically significant for splitting node 5 is the X_{69} coded variable, which refers to the situation of whether or not the student is comfortable with using his/her own digital device in his/her home ($F_{(2, 308)}= 15.910$, $p< .001$). When node 13, comprised of students expressing strong disagreement or disagreement with this statement, node 14, comprised of students who stated agreement and node 15, expressing strong agreement, were examined, it was observed that the highest average score belonged to node 5. Based on this finding, it can be maintained that the mathematics literacy scores of the students with the perception that they could comfortably use the digital device at home were higher. The variable that significantly categorized node 6 is the X67 coded variable, which refers to the whether or not
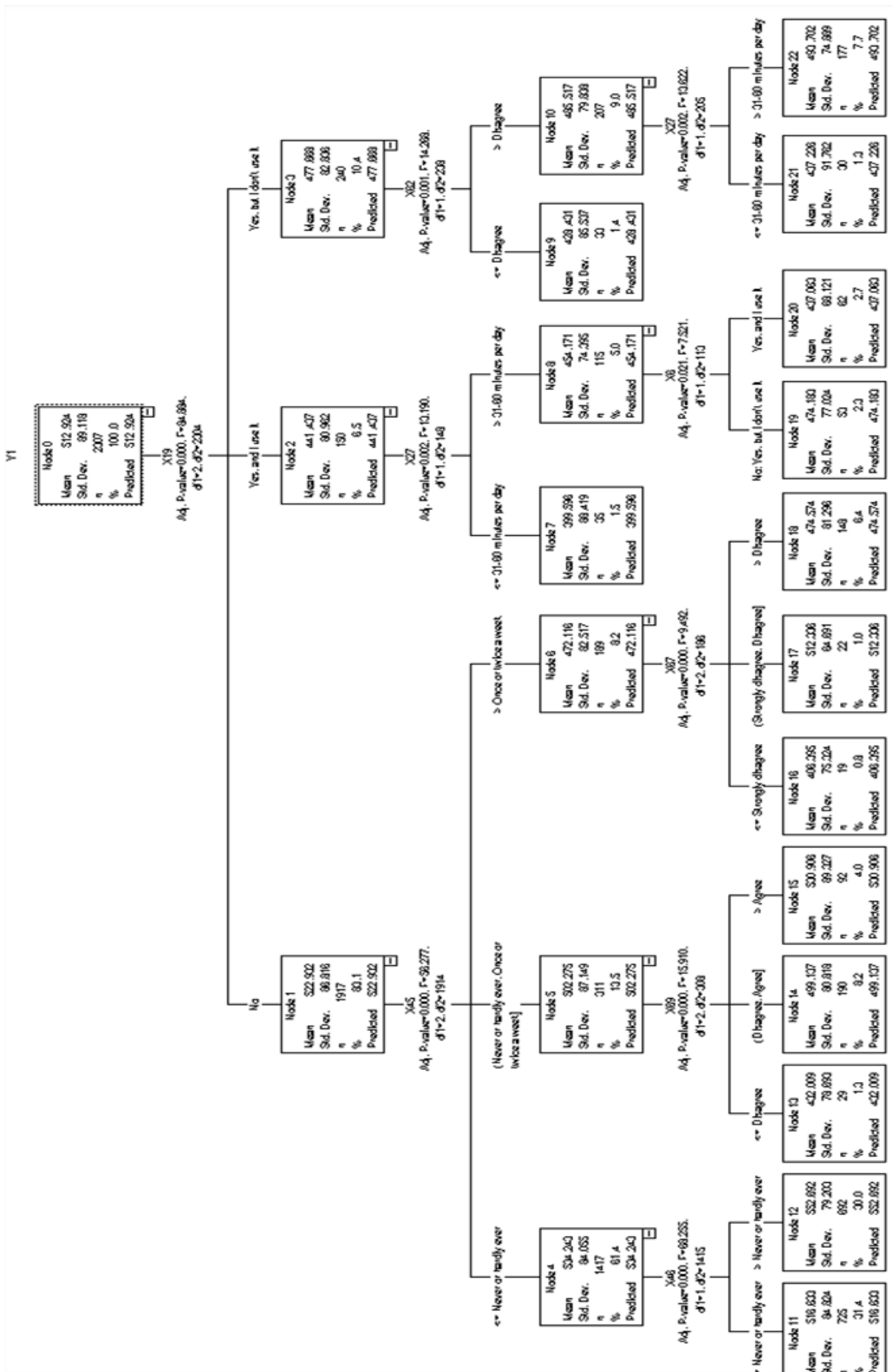
Figure 1. Decision Tree

students feel comfortable when using an unfamiliar digital device ($F_{(2, 186)}$= 9.492, p< .001). When node 16, comprised of students who expressed strong disagreement, node 17, consisting of students expressing disagreement or strong agreement, and node 18, consisting of students expressing agreement or strong agreement are examined, it can be observed that the highest average score belonged to node 17. When Figure 1 is examined, it can be observed that the variable that significantly categorized node 8 into sub-nodes was the X_6 coded variable, which refers to whether or not there was access to a telephone with no Internet access ($F_{(1, 113)}$= 7.521, p< .05). Node 19 consisted of students who marked "No" or "Yes, but I don't use it" for this statement node 20 was comprised of students who marked "Yes, and I use it." Since the average mathematics literacy score of the students in node 19 was higher, it can be deduced that a mobile telephone with no Internet access did not increase students' mathematics literacy scores. The variable that split node 10 – the last parent node – into sub-nodes (which also split node 2 into significant nodes) is observed to be the X_{27} coded variable, which refers to the situation related to the duration of Internet use out of school at the weekend ($F_{(1, 205)}$= 13.622, p< .01). It produced the following two groups: node 21 and node 22, which contained less than or equal to 31-60 minutes of Internet use per day and more than 31-60 minutes per day, respectively. When node 21 and node 22 were examined, it was found that the students who used the Internet for longer durations had higher mathematics literacy scores.

The categorization process in CHAID analysis does not end until the entire performance of the model is evaluated. None of the results examined so far indicate whether this is a particularly good model (IBM-SPSS, 2012). Thus, the risk estimate table, displaying the model performance, also needs to be considered. For scale dependent variables, the risk estimate is within-node variance and lower variance indicates a better model, but the variance is relative to the unit of measurement (IBM-SPSS, 2012). The crossvalidated risk estimate for the final tree is calculated as the average of the risks for all of the trees. Tables 2 presents basic information about the performance of the developed CHAID model in terms of its accuracy and predictive potential.

Table 2. *Risk for mathematical literacy score*

Method	Estimate	Std. Error
Re-substitution	6572.308	198.909
Cross-Validation	7020.372	214.922

To interpret risk estimate meaningfully, a multistaged computation needs to be done (IBM-SPSS, 2012). The within-node variance is the risk estimate value for the re-substitution model: 6572.31. The standard deviation displayed at the root node is 198.91; so the total variance is that value squared: 39564.74. The proportion of variance due to error (unexplained variance) is 6572.31/39564.74= 0.166. The proportion of variance explained by the model is 1–0.17= 0.834 or 83.4%, which indicates that this is a fairly good model, while that risk, when a test sample is used in model cross-validation, is 0.848 or 84.8%.

The decision tree, which belonged to the CHAID analysis in which the science literacy scores were addressed as the dependent variable and a total of 81 variables in the ICT Familiarity Questionnaire is addressed as independent variables, is a rather large diagram including 33 nodes. That is why the figure of this decision tree was not included in the present study; only the interpretations were made. Of these 33 nodes, 22 were terminal nodes and were identified as depth 3. The students' average science literacy score and the standard deviation were calculated

as 518.18 and 91.922, respectively. Based on this average score, it can be deduced that the science literacy of the students comprising the sample of the study was at level 3 (OECD, 2017, p.283).

As a result of the CHAID analysis, the independent variable that has the strongest relationship with the dependent variable of science literacy scores and the strongest ability of splitting the nodes into subnodes was found to be X45-students' use of social network for communicating with their teachers ($F_{(2, 2304)}$= 112.434, p< .001). Three sub-nodes were formed to include the categories of the X_{45} variable. For X_{45} within the first level of the tree, nodes 1, 2 and 3 are parent nodes. Node 1 consists of 1596 students who stated that they never or hardly ever communicated with their teachers via social network, node 2 is comprised of 233 students stating that they communicated with their teachers once or twice a month, and node 3 consists of 478 students stating that they communicated with their teachers more than once or twice a month. When nodes 1, 2 or 3 are examined, it can be observed that students' science literacy scores decrease as the frequency of communication with their teachers via social network out of school boundaries increases.

Within the second level of the tree, three statistically significant variables were identified, which are X_{22} – the age at which students first used a digital device, X_{69} – whether or not students were comfortable with using their own digital device at home, and X_{19}– whether or not there was an ebookreader for students to use at school. Variable X_{22} was found to be significant for splitting of node 1 ($F_{(3, 1592)}$= 33.086, p< .001). Accordingly, the categories formed by four groups of respondents are as follows: node 4 consists of 562 students stating that they were 6 years or younger when they first used a digital device, node 5 consists of 654 students who stated that they first used a digital device at 7-9 years of age, node 6 is comprised of 316 students stating that they first used a digital device at the age of 10-12 years and node 7 consists of 64 students who reported that they first used a digital device when they were 13 years or older. When the nodes formed by the ages at which a digital device was first used were examined, it was revealed that the highest science literacy scores belonged to node 4 and that the higher the age at which the first digital device was used, the lower these average scores were. Variable X_{69} was found to be significant for splitting of node 2 ($F_{(2, 230)}$= 20.385, p< .001). A comparative examination of node 8, comprised of students stating strong disagreement or disagreement, node 9, consisting of students indicating agreement, and node 10, consisting of students stating strong agreement, shows that the highest average score belongs to node 10. Based on this finding, it can be deduced that students who hold the perception that they can easily use digital devices at home have higher science literacy scores. The variable that was found to split node 3 into significant sub-nodes was found to be the X_{19} coded variable ($F_{(1, 476)}$= 23.944, p< .001). As a result of this analysis conducted based on science literacy scores, it was found that 315 students who gave the response "No" to the variable of wether or not there was an ebookreader for students to use at school formed node 11 and 163 students who gave the response "Yes" formed node 12. When these nodes are compared, it can be observed that the average science literacy scores of students who did not have an ebookreader at school were higher.

In the third level of the tree depth, the variable that was found to be statistically significant for splitting node 4 was X_{39} – Use digital devices out of the school for downloading new apps on a mobile device ($F_{(2, 559)}$= 22.063, p< .001). Node 13 was formed of 300 students who reported less than or equal to once or twice a month, node 14 was com-

prised of 213 students who reported once or twice a week or almost every day, and node 15 was composed of 75 students who reported every day. The highest science literacy average score was found to belong to node 13. Accordingly, it can be deduced that the higher the frequency of using digital devices outside school for downloading new apps on a mobile device was, the lower the students' average scores were. The variable that was found to be statistically significant for splitting node 5 was X_{40} ($F_{(1, 652)}$= 34.313, $p<$ .001). For this variable, which refers to the frequency of browsing the Internet for schoolwork, two nodes - node 16 and node 17 – were formed. When these nodes were examined, it was found that the average score of the students who never or hardly ever browsed the Internet for schoolwork was lower when compared to those students who reported browsing the Internet for schoolwork at least once or twice a month. Based on this finding, it can be deduced that the higher the frequency of students' browsing the Internet for schoolwork was, the higher their science literacy scores were. The variable that was found to be statistically significant for splitting node 6 was X_{36} ($F_{(2, 313)}$= 12.9003, $p<$ .001). Three nodes –node 18, node 19 and node 20– were formed for this variable related to the frequency of using digital devices outside school for obtaining practical information from the Internet. When the average scores in these nodes were examined, it was revealed that the science literacy scores of students who used digital devices outside school for obtaining practical information from the Internet almost every day were higher. The variable that was found to be statistically significant for splitting node 7 was X_{37} ($F_{(2, 61)}$= 7.725, $p<$ .01). This variable, related to using digital devices outside school for downloading music, films, games or software from the Internet, was split into three nodes, namely node 21, node 22, and node 23. It was revealed the students who reported once or twice a month or once or twice a week for this variable had a higher science literacy average score. However, it was observed that node 23, which was composed of students reporting more than once or twice a week, had a lower average score in science literacy when compared to the other two nodes. For this reason, it can be deduced that there is a negative relationship between the student scores and the frequent use of the Internet for downloading music, films, games or software.

The variable that was found to be statistically significant for splitting node 9 was X_{22} ($F_{(1, 146)}$= 15.428, $p<$ .001). This variable is related to the age of the student at which a digital device was first used. Node 24 consisted of 108 students who stated that they first used a digital device when they were younger than or equal to 7-9 years of age, while node 25 was comprised of students who reported above 7-9 years of age. A higher science average was yielded in node 24. Based on this finding, it can be deduced that using digital devices at younger ages increases students' science literacy scores. The variable that was found to be statistically significant for splitting node 10 was the previously mentioned X40 variable ($F_{(1, 59)}$= 7.806, $p<$ .05). For this variable related to the frequency of browsing the Internet for schoolwork, two nodes were formed – node 26 and node 27. When these nodes were examined, it was revealed that the average score of the students who reported that they browsed the Internet for schoolwork less than or equal to once or twice a month was lower than those who reported at least once or twice a month.

The variable that was found to be statistically significant for splitting node 11 was the previously mentioned X_{27} ($F_{(2, 312)}$= 9.361, $p<$ .01). Three nodes – node 28, node 29 and node 30 – were formed related to duration of students' use of the Internet outside of school at weekends. When these nodes were examined, it was revealed that the highest average science scores were obtained from the cat-

egories of 31-60 minutes per day and between 4 hours and 6 hours per day. It was revealed that the as the duration of Internet usage was shorter than 31-60 minutes or longer than between 4 and 6 hours per day, the lower the students' scores were. The variable that was found to be statistically significant for splitting node 12 was X_{75} ($F_{(2, 160)}$=7.900, $p<$ .01). Node 3 was found to be comprised of 31 students who strongly disagreed or disagreed with the statement, "If I have a problem with digital devices I start to solve it on my own," while node 32 was composed of 95 students who agreed, and node 33 consisted of 37 students who strongly agreed. It was revealed that the group with the highest science literacy average was node 33.

The risk table obtained to evaluate whether or not the model constructed for science literacy is presented in Table 3.

Table 2. *Risk for scientific literacy score*

Method	Estimate	Std. Error
Re-substitution	6675.081	190.544
Cross-Validation	7464.804	214.678

The proportion of variance explained by the model with the re-substitution model is 0.816 or 81.6%, and when a test sample is used in model cross-validation, the proportion of variance explained is 0.838 or 83.8%, which indicates that this is a fairly good model.

Discussion, Conclusions and Recommendations

As a result of the CHAID analysis, conducted to reveal the ICT items related to mathematics literacy scores, it was revealed that there was a significant relationship between mathematics literacy scores and the variables coded as X_{19}, X_{45}, X_{46}, X_{69}, X_{67}, X_{27}, X_6, X_{62}.

Of these variables, the variable that yielded the most important relationship with mathematics literacy scores was X19: Digitial devices available at school: <ebook reader>. It was revealed that the highest mathematics literacy average score belonged to students who did not have an ebookreader in their school, while the lowest mathematics literacy average score belonged to those students who had an ebookreader that they could and did use in their school. This result could have derived from the fact that students in the field of mathematics do computations based more on pen and paper. Another striking finding of the study is that the higher the frequencies of students' use of social network for communicating with their teachers were, the lower their mathematics literacy scores were. This could stem from the fact that students may not be limited to communicating with their teachers on social network, but deviating from these platforms when they are online in these social networks, which can be time consuming. Moreover, it was revealed that using digital devices and the Internet for education purposes had a positive effect on mathematics literacy scores. The findings of the study revealed that among the categorizations made, those who had higher mathematics literacy scores were those student who used the Internet for longer periods of time, who agreed with the view that the Internet was a great source in relation to topics of interest, who downloaded/uploaded/browsed their school website more frequently, who felt comfortable using their own digital device at home, who did not feel comfortable using an unfamiliar digital device, and who reported that they had access to a mobile phone with Internet connection at home, but did not use it. Based on these findings, it can be concluded that there is a relationship between mathematics literacy scores and the conditions of ICT being available at school, ICT being used outside of school for schoolwork,

and students' perceived ICT competence.

As a result of the CHAID analysis, conducted to reveal the ICT items related to science literacy scores, it was revealed that there was a significant relationship between science literacy scores and the variables coded as X_{45}, X_{22}, X_{39}, X_{40}, X_{36}, X_{37}, X_{69}, X_{19}, $X_{27,\ and}$ X_{75}. Of these variables, the variable that yielded the most important relationship with science literacy scores was X45: Frequency of use outside of school: Using Social Networks for communication with teachers. It was revealed that similar to the condition with mathematics literacy scores, there was a decrease in students' science literacy scores as the frequency of students' use of social network for communication with their teachers increased. Another variable that was revealed to have a negative relationship with science literacy scores was the increase in the age at which a digital device was first used. It can be claimed that the condition in which a student uses a digital device at a young age increases science literacy scores. Another variable that has been revealed to have a significant relationship with science literacy scores was digitial devices available at school: <ebook reader>. It was observed that with respect to this variable, as was the case in mathematics literacy scores, those students who did not have an ebookreader in their school had higher science literacy scores. The higher the frequency of students' use of digital devices outside school for downloading new apps on a mobile device was, the lower the students' science literacy scores were. This condition could be attributed to the fact that students may not be using these devices for educational purposes. When the overall categorization for science literacy is viewed, it can be concluded that there is a relationship between students' science literacy scores and ICT use outside of school leisure, ICT use outside of school for schoolwork, and students' perceived autonomy related to ICT use.

As a result of the analyses in which two different dependent variables were used, it was revealed that there was a significant relationship between the X_{19}, X_{27}, X_{45}, X_{69} variables and both mathematics and science literacy. When the results obtained from these variables were generally examined, it can be deduced that the conditon of merely having and using ICT does not relationship with the mathematics and science literacy scores. For what purpose students use ICT should also be investigated. There is a relationship between high science and mathematics literacy scores and using digital devices at an early age as well as feeling comfortable with using digital devices at home. As an outcome of the CHAID algorithm, the realization of a significant reduction was achieved in the dimensionality of both models. The selected variables can be used for future research and development of new, parametric models. In the resulting model, apart from the reduction of the number of predictors, the reduction of their categories was also achieved. For example, in its original form, variable X_{27} (IC007Q01TA) has 7 categories (Table 1), and 2 categories in the model (Figure 1).

As previously mentioned in the present article, there are numerous studies on ICT in the literature and different findings are reported. In the present study, it was revealed that of the items related to frequency of using social network, student performance is only significantly related to the use of social network when communicating with the teacher. However, this is a one-way relationship.

Similar to this finding of the present study, Paul, Baker and Cochran (2012) reveals a statistically significant negative relationship between time spent on social networks and academic performance. Similarly, Karpinski & Duberstein (2009) reported that students who frequently used social network services had decreased levels of productivity in academic environments. It was mentioned in a study by Englander, Terregrossa and Wang (2010) that social network was generally not used for academic purposes, which could cause problems in the area of student achievement. However, there is no agreement in the literature in this area as well. Rideout (2012) reported that the students who used social media according to the teachers made 54% progress in their maths skills and 51% progress in their science skills. Thus, to arrive at a decision concerning social network, more attention needs to be placed upon for what purposes these networks are used rather than the amount of time spent on the social network or who are contacted.

In the present study, it was concluded that the presence of e-bookreaders, which are mobile devices, in the school does not increase students' science and mathematics literacy scores. This result coud be attributed to the fact that students are more familiar to traditional classrooms, they cannot easily access the Internet, and the subjects under study are numeric subjects. However, different from the finding of the current study, in a study by Larson (2010), in which conditions where eReaders, particularly Kindle, were used to read eBooks in class were examined, it was revealed that use of Kindle resulted in a better interaction with the text and a deeper conceptualization. Another finding of the current study was that having access to technology at young ages increased literacy scores. In a study conducted with pre-school teachers, Sandberg (2002) reported that pre-school teachers believed that use of ICT in their classrooms was important for the cognitive development of students. It was also revealed that there was a relationship between students' use of ICT outside of school for schoolwork and their academic achievements. Underwood, Billingham and Underwood (1994) stated that experiences with the computer out of the school could have an impact on students' school achievement levels. As in the metaanalysis study by Torgerson and Zhu (2003), in the present study, the fact that use of ICT increases student performance can be emphasized.

The findings which the present study yielded seems to be consistent with the fact that there is a relationship betwen students' use of ICT and their mathematics and science literacy scores. However, to reveal the reasons or effects of this relationship, experimental or qualitiatives studies need to be conducted in this area. The ICT items addressed as independent variables in the present study are noncontinuous variables. By using almost all of the items in the ICT questionnaire in PISA, nine separate index scores were established. These variables, which were made continuous, can be included in the study as indepedent variables. The relationships, which were tried to be revealed via CHAID, a nonparametric analysis method, could be examined by utilizing more powerful statistical methods. As there are ICT items in the questionnaires of TIMSS as well, a similar study could be replicated with the data of TIMSS. Educational programs in which use of ICT for academic purposes is encouraged can be constructed, and teachers can be provided with seminars on the effective use of ICT.

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Appendix

Table 1. *Sample structure according to variables used in CHAID analysis*

Variable Name	Code	Label	Categories and Codes	Measurement	Types of Variables
IC001Q01TA	X_1	Available for you to use at home: Desktop compu-ter	Never or hardly ever (1) Once or twice a month (2) Once or twice a week (3) Almost every day (4) Every day (5)	Nominal	Independent Variable
IC001Q02TA	X_2	Available for you to use at home: Portable laptop, or notebook	Never or hardly ever (1) Once or twice a month (2) Once or twice a week (3) Almost every day (4) Every day (5)	Nominal	Independent Variable
IC001Q03TA	X_3	Available for you to use at home: <Tablet compu-ter>	Never or hardly ever (1) Once or twice a month (2) Once or twice a week (3) Almost every day (4) Every day (5)	Nominal	Independent Variable
IC001Q04TA	X_4	Available for you to use at home: Internet connec-tion	Never or hardly ever (1) Once or twice a month (2) Once or twice a week (3) Almost every day (4) Every day (5)	Nominal	Independent Variable
IC001Q05TA	X_5	Available for you to use at home: <Video games console>	Never or hardly ever (1) Once or twice a month (2) Once or twice a week (3) Almost every day (4) Every day (5)	Nominal	Independent Variable
IC001Q06TA	X_6	Available for you to use at home: <Cell phone> (without Internet access)	Never or hardly ever (1) Once or twice a month (2) Once or twice a week (3) Almost every day (4) Every day (5)	Nominal	Independent Variable
IC001Q07TA	X_7	Available for you to use at home: <Cell phone> (with Internet access)	Never or hardly ever (1) Once or twice a month (2) Once or twice a week (3) Almost every day (4) Every day (5)	Nominal	Independent Variable
IC001Q08TA	X_8	Available for you to use at home: Portable music player	Never or hardly ever (1) Once or twice a month (2) Once or twice a week (3) Almost every day (4) Every day (5)	Nominal	Independent Variable
IC001Q09TA	X_9	Available for you to use at home: Printer	Never or hardly ever (1) Once or twice a month (2) Once or twice a week (3) Almost every day (4) Every day (5)	Nominal	Independent Variable
IC001Q10TA	X_{10}	Available for you to use at home: USB (memory) stick	Never or hardly ever (1) Once or twice a month (2) Once or twice a week (3) Almost every day (4) Every day (5)	Nominal	Independent Variable
IC001Q11TA	X_{11}	Available for you to use at home: <ebook reader>	Never or hardly ever (1) Once or twice a month (2) Once or twice a week (3) Almost every day (4) Every day (5)	Nominal	Independent Variable
IC009Q01TA	X_{12}	Digitial devices available at school: Desktop com-puter	Never or hardly ever (1) Once or twice a month (2) Once or twice a week (3) Almost every day (4) Every day (5)	Nominal	Independent Variable
IC009Q02TA	X_{13}	Digitial devices available at school: Portable laptop or notebook	Never or hardly ever (1) Once or twice a month (2) Once or twice a week (3) Almost every day (4) Every day (5)	Nominal	Independent Variable
IC009Q03TA	X_{14}	Digitial devices available at school: <Tablet compu-ter>	Never or hardly ever (1) Once or twice a month (2) Once or twice a week (3) Almost every day (4) Every day (5)	Nominal	Independent Variable

IC009Q05NA	X_{15}	Digitial devices available at school: Internet con-nected school com-puters	Never or hardly ever (1) Once or twice a month (2) Once or twice a week (3) Almost every day (4) Every day (5)	Nominal	Independent Variable
IC009Q06NA	X_{16}	Digitial devices available at school: Internet con-nection via wireless network	Never or hardly ever (1) Once or twice a month (2) Once or twice a week (3) Almost every day (4) Every day (5)	Nominal	Independent Variable
IC009Q07NA	X_{17}	Digitial devices available at school: Storage space for school-related data	Never or hardly ever (1) Once or twice a month (2) Once or twice a week (3) Almost every day (4) Every day (5)	Nominal	Independent Variable
IC009Q08TA	X_{18}	Digitial devices available at school: USB (memory) stick	Never or hardly ever (1) Once or twice a month (2) Once or twice a week (3) Almost every day (4) Every day (5)	Nominal	Independent Variable
IC009Q09TA	X_{19}	Digitial devices available at school: <ebook reader>	Never or hardly ever (1) Once or twice a month (2) Once or twice a week (3) Almost every day (4) Every day (5)	Nominal	Independent Variable
IC009Q10NA	X_{20}	Digitial devices available at school: Data projector	Never or hardly ever (1) Once or twice a month (2) Once or twice a week (3) Almost every day (4) Every day (5)	Nominal	Independent Variable
IC009Q11NA	X_{21}	Digitial devices available at school: Interactive Whiteboard	Never or hardly ever (1) Once or twice a month (2) Once or twice a week (3) Almost every day (4) Every day (5)	Nominal	Independent Variable
IC002Q01NA	X_{22}	How old were you when you first used a digital device?	Never or hardly ever (1) Once or twice a month (2) Once or twice a week (3) Almost every day (4) Every day (5)	Ordinal	Independent Variable
IC003Q01TA	X_{23}	How old were you when you first used a compu-ter?	Never or hardly ever (1) Once or twice a month (2) Once or twice a week (3) Almost every day (4) Every day (5)	Ordinal	Independent Variable
IC004Q01TA	X_{24}	How old were you when you first accessed the Internet?	Never or hardly ever (1) Once or twice a month (2) Once or twice a week (3) Almost every day (4) Every day (5)	Ordinal	Independent Variable
IC005Q01TA	X_{25}	During a typical weekday, for how long do you use the Internet at school?	Never or hardly ever (1) Once or twice a month (2) Once or twice a week (3) Almost every day (4) Every day (5)	Ordinal	Independent Variable
IC006Q01TA	X_{26}	During a typical weekday, for how long do you use the Internet outside of school?	Never or hardly ever (1) Once or twice a month (2) Once or twice a week (3) Almost every day (4) Every day (5)	Ordinal	Independent Variable
IC007Q01TA	X_{27}	On a typical weekend day, for how long do you use the Internet outside of school?	Never or hardly ever (1) Once or twice a month (2) Once or twice a week (3) Almost every day (4) Every day (5)	Ordinal	Independent Variable
IC008Q01TA	X_{28}	Use digital devices outsi-de school for playing one-player games.	Never or hardly ever (1) Once or twice a month (2) Once or twice a week (3) Almost every day (4) Every day (5)	Ordinal	Independent Variable
IC008Q02TA	X_{29}	Use digital devices outsi-de school for playing collaborative online ga-mes.	Never or hardly ever (1) Once or twice a month (2) Once or twice a week (3) Almost every day (4) Every day (5)	Ordinal	Independent Variable

IC008Q03TA	X_{30}	Use digital devices outsi-de school for using email.	Never or hardly ever (1) Once or twice a month (2) Once or twice a week (3) Almost every day (4) Every day (5)	Ordinal	Independent Variable
IC008Q04TA	X_{31}	Use digital devices outsi-de school for <Chatting online>	Never or hardly ever (1) Once or twice a month (2) Once or twice a week (3) Almost every day (4) Every day (5)	Ordinal	Independent Variable
IC008Q05TA	X_{32}	Use digital devices outsi-de school for social networks	Never or hardly ever (1) Once or twice a month (2) Once or twice a week (3) Almost every day (4) Every day (5)	Ordinal	Independent Variable
IC008Q07NA	X_{33}	Use digital devices outsi-de school for online ga-mes\Social Networks	Never or hardly ever (1) Once or twice a month (2) Once or twice a week (3) Almost every day (4) Every day (5)	Ordinal	Independent Variable
IC008Q08TA	X_{34}	Use digital devices outsi-de school for browsing the Internet for fun videos	Never or hardly ever (1) Once or twice a month (2) Once or twice a week (3) Almost every day (4) Every day (5)	Ordinal	Independent Variable
IC008Q09TA	X_{35}	Use digital devices outsi-de school for reading news on the Internet	Never or hardly ever (1) Once or twice a month (2) Once or twice a week (3) Almost every day (4) Every day (5)	Ordinal	Independent Variable
IC008Q10TA	X_{36}	Use digital devices outsi-de school for obtaining practical information from the Internet	Never or hardly ever (1) Once or twice a month (2) Once or twice a week (3) Almost every day (4) Every day (5)	Ordinal	Independent Variable
IC008Q11TA	X_{37}	Use digital devices outsi-de school for downloa-ding music, films, games or software from the In-ternet.	Never or hardly ever (1) Once or twice a month (2) Once or twice a week (3) Almost every day (4) Every day (5)	Ordinal	Independent Variable
IC008Q12TA	X_{38}	Use digital devices outsi-de school for uploading your own created con-tents for sharing	Never or hardly ever (1) Once or twice a month (2) Once or twice a week (3) Almost every day (4) Every day (5)	Ordinal	Independent Variable
IC008Q13NA	X_{39}	Use digital devices outsi-de school for downloa-ding new apps on a mobi-le device.	Never or hardly ever (1) Once or twice a month (2) Once or twice a week (3) Almost every day (4) Every day (5)	Ordinal	Independent Variable
IC010Q01TA	X_{40}	Frequency of use outside of school: Browsing the Internet for school-work	Never or hardly ever (1) Once or twice a month (2) Once or twice a week (3) Almost every day (4) Every day (5)	Ordinal	Independent Variable
IC010Q02NA	X_{41}	Frequency of use outside of school: Browsing the Internet to follow up les-sons, e.g. for finding explana-tions.	Never or hardly ever (1) Once or twice a month (2) Once or twice a week (3) Almost every day (4) Every day (5)	Ordinal	Independent Variable
IC010Q03TA	X_{42}	Frequency of use outside of school: Using email for communication with other students about schoolwork.	Never or hardly ever (1) Once or twice a month (2) Once or twice a week (3) Almost every day (4) Every day (5)	Ordinal	Independent Variable
IC010Q04TA	X_{43}	Frequency of use outside of school: Using email for communication with te-acher\submit of ho-mework or other schoolwork	Never or hardly ever (1) Once or twice a month (2) Once or twice a week (3) Almost every day (4) Every day (5)	Ordinal	Independent Variable
IC010Q05NA	X_{44}	Frequency of use outside of school: Using Social Networks for commu-nica-tion with other students about schoolwork.	Never or hardly ever (1) Once or twice a month (2) Once or twice a week (3) Almost every day (4) Every day (5)	Ordinal	Independent Variable

IC010Q06NA	X_{45}	Frequency of use outside of school: Using Social Networks for communi-ca-tion with teachers.	Never or hardly ever (1) Once or twice a month (2) Once or twice a week (3) Almost every day (4) Every day (5)	Ordinal	Independent Variable
IC010Q07TA	X_{46}	Frequency of use outside of school: Down-load\upload\browsing from school website	Never or hardly ever (1) Once or twice a month (2) Once or twice a week (3) Almost every day (4) Every day (5)	Ordinal	Independent Variable
IC010Q08TA	X_{47}	Frequency of use outside of school: Checking the schools website for anno-uncements.	Never or hardly ever (1) Once or twice a month (2) Once or twice a week (3) Almost every day (4) Every day (5)	Ordinal	Independent Variable
IC010Q09NA	X_{48}	Frequency of use outside of school: Doing ho-mework on a computer.	Never or hardly ever (1) Once or twice a month (2) Once or twice a week (3) Almost every day (4) Every day (5)	Ordinal	Independent Variable
IC010Q10NA	X_{49}	Frequency of use outside of school: Doing ho-mework on a mobile de-vice.	Never or hardly ever (1) Once or twice a month (2) Once or twice a week (3) Almost every day (4) Every day (5)	Ordinal	Independent Variable
IC010Q11NA	X_{50}	Frequency of use outside of school: Downloading learning apps on a mobile device.	Never or hardly ever (1) Once or twice a month (2) Once or twice a week (3) Almost every day (4) Every day (5)	Ordinal	Independent Variable
IC010Q12NA	X_{51}	Frequency of use outside of school: Downloading science learning apps on a mobile device.	Never or hardly ever (1) Once or twice a month (2) Once or twice a week (3) Almost every day (4) Every day (5)	Ordinal	Independent Variable
IC011Q01TA	X_{52}	Frequency of use at school: <Chat-ting on line> at school.	Never or hardly ever (1) Once or twice a month (2) Once or twice a week (3) Almost every day (4) Every day (5)	Ordinal	Independent Variable
IC011Q02TA	X_{53}	Frequency of use at school: Using email at school.	Never or hardly ever (1) Once or twice a month (2) Once or twice a week (3) Almost every day (4) Every day (5)	Ordinal	Independent Variable
IC011Q03TA	X_{54}	Frequency of use at school: Brows-ing the Internet for schoolwork.	Never or hardly ever (1) Once or twice a month (2) Once or twice a week (3) Almost every day (4) Every day (5)	Ordinal	Independent Variable
IC011Q04TA	X_{55}	Frequency of use at school: Down-load\upload\browse schools web	Never or hardly ever (1) Once or twice a month (2) Once or twice a week (3) Almost every day (4) Every day (5)	Ordinal	Independent Variable
IC011Q05TA	X_{56}	Frequency of use at school: Posting my work on the schools website.	Never or hardly ever (1) Once or twice a month (2) Once or twice a week (3) Almost every day (4) Every day (5)	Ordinal	Independent Variable
IC011Q06TA	X_{57}	Frequency of use at school: Playing simulati-ons at school.	Never or hardly ever (1) Once or twice a month (2) Once or twice a week (3) Almost every day (4) Every day (5)	Ordinal	Independent Variable
IC011Q07TA	X_{58}	Frequency of use at school: Prac-ticing and drilling, foreign language learning or math.	Never or hardly ever (1) Once or twice a month (2) Once or twice a week (3) Almost every day (4) Every day (5)	Ordinal	Independent Variable
IC011Q08TA	X_{59}	Frequency of use at school: Doing homework on a school computer.	Never or hardly ever (1) Once or twice a month (2) Once or twice a week (3) Almost every day (4) Every day (5)	Ordinal	Indpendent Variable

IC011Q09TA	X_{60}	Frequency of use at school: Using school computers for group work and communication with other students.	Never or hardly ever (1) Once or twice a month (2) Once or twice a week (3) Almost every day (4) Every day (5)	Ordinal	Independent Variable
IC013Q01NA	X_{61}	I forget about time when I'm using digital devices.	Strongly disagree (1) Disagree (2) Agree (3) Strongly agree (4)	Ordinal	Independent Variable
IC013Q04NA	X_{62}	The Internet is a great resource for obtaining information I am interes-ted in	Strongly disagree (1) Disagree (2) Agree (3) Strongly agree (4)	Ordinal	Independent Variable
IC013Q05NA	X_{63}	It is very useful to have Social Net-works on the Internet.	Strongly disagree (1) Disagree (2) Agree (3) Strongly agree (4)	Ordinal	Independent Variable
IC013Q11NA	X_{64}	I am really excited disco-vering new digital devices or applications.	Strongly disagree (1) Disagree (2) Agree (3) Strongly agree (4)	Ordinal	Independent Variable
IC013Q12NA	X_{65}	I really feel bad if no Internet con-nection is possible.	Strongly disagree (1) Disagree (2) Agree (3) Strongly agree (4)	Ordinal	Independent Variable
IC013Q13NA	X_{66}	I like using digital devi-ces.	Strongly disagree (1) Disagree (2) Agree (3) Strongly agree (4)	Ordinal	Independent Variable
IC014Q03NA	X_{67}	I feel comfortable using digital de-vices that I am less familiar with.	Strongly disagree (1) Disagree (2) Agree (3) Strongly agree (4)	Ordinal	Independent Variable
IC014Q04NA	X_{68}	If my friends and relatives want to buy new digital devices or applica-tions, I can give them advice.	Strongly disagree (1) Disagree (2) Agree (3) Strongly agree (4)	Ordinal	Independent Variable
IC014Q06NA	X_{69}	I feel comfortable using my digital devices at ho-me.	Strongly disagree (1) Disagree (2) Agree (3) Strongly agree (4)	Ordinal	Independent Variable
IC014Q08NA	X_{70}	When I come across prob-lems with digital devices, I think I can solve them.	Strongly disagree (1) Disagree (2) Agree (3) Strongly agree (4)	Ordinal	Independent Variable
IC014Q09NA	X_{71}	If my friends and relatives have a problem with digi-tal devices, I can help them.	Strongly disagree (1) Disagree (2) Agree (3) Strongly agree (4)	Ordinal	Independent Variable
IC015Q02NA	X_{72}	If I need new software, I install it by myself.	Strongly disagree (1) Disagree (2) Agree (3) Strongly agree (4)	Ordinal	Independent Variable
IC015Q03NA	X_{73}	I read information about digital devices to be inde-pendent.	Strongly disagree (1) Disagree (2) Agree (3) Strongly agree (4)	Ordinal	Independent Variable
IC015Q05NA	X_{74}	I use digital devices as I want to use them.	Strongly disagree (1) Disagree (2) Agree (3) Strongly agree (4)	Ordinal	Independent Variable
IC015Q07NA	X_{75}	If I have a problem with digital de-vices I start to solve it on my own.	Strongly disagree (1) Disagree (2) Agree (3) Strongly agree (4)	Ordinal	Independent Variable
IC015Q09NA	X_{76}	If I need a new applica-tion, I choose it by my-self.	Strongly disagree (1) Disagree (2) Agree (3) Strongly agree (4)	Ordinal	Independent Variable
IC016Q01NA	X_{77}	To learn something new about digi-tal devices, I like to talk about them with my friends.	Strongly disagree (1) Disagree (2) Agree (3) Strongly agree (4)	Ordinal	Independent Variable

IC016Q02NA	X_{78}	I like to exchange soluti-ons to problems with digital devices with others on the Internet.	Strongly disagree (1) Disagree (2) Agree (3) Strongly agree (4)	Ordinal	Independent Variable
IC016Q04NA	X_{79}	I like to meet friends and play computer and video games with them.	Strongly disagree (1) Disagree (2) Agree (3) Strongly agree (4)	Ordinal	Independent Variable
IC016Q05NA	X_{80}	I like to share information about digital devices with my friends.	Strongly disagree (1) Disagree (2) Agree (3) Strongly agree (4)	Ordinal	Independent Variable
IC016Q07NA	X_{81}	I learn a lot about digital media by discussing with my friends and relatives.	Strongly disagree (1) Disagree (2) Agree (3) Strongly agree (4)	Ordinal	Independent Variable
PV1MATH	Y_1	Math literacy score	Strongly disagree (1) Disagree (2) Agree (3) Strongly agree (4)	Scale	Dependent Variable
PV1SCIE	Y_2	Science literacy score	Strongly disagree (1) Disagree (2) Agree (3) Strongly agree (4)	Scale	Dependent Variable

Use of Mixed Item Response Theory in Rating Scales

Seher Yalçın[*]

Abstract

This study aimed to compare the Graded Response Model (GRM) and the Mixed-Graded Response Model (MixGRM) in terms of model data-fit and parameters and demonstrate the application of MixGRM on real data. In this context, this study is basic research based on the International Computer and Information Literacy Study in 2013 conducted with eighth-grade participants from Turkey. The data from a total of 2,356 students were used in the study. In testing the models, data was obtained from an 11-item Likert scale that measured the students' interest and enjoyment in using Information and Communication Technologies (ICTs). When the GRM- and MixGRM-based model data-fit results were compared, the model with the best fit was the MixGRM with four latent classes. Students who reported to enjoy using ICT and who had the highest computer and information literacy (CIL) score were found to be in the first latent class, those with least enjoyment or dislike and those with the lowest CIL score were in the fourth latency class. The findings show that reducing the heterogeneity of Mixed-Item Response Theory models in the dataset is a preferable model for research situations and that Turkish students are not yet prepared for life in the digital age.

Keywords: Graded Response Model, Mixture Item Response Theory, Latent Class Analysis, Mixture Graded Response Model, Information And Communication Technologies

Introduction

Different models and theories are being developed to make decisions about the results of tests taken by individuals more valid and reliable. The theories most often referred to in the literature are; classical test and item response theory (IRT). The classical test theory has certain limitations (Hambleton, Swaminathan & Rogers, 1991), such as being dependent on group, individuals' being dependent on the item they receive, the quality of the item being dependent on the responding group, thus the difficulty of comparing the individuals who take the different tests, being test based and the need for parallel tests for the reliability prediction. Therefore, given these limitations, IRT models are more frequently preferred. Two reasons for this preference are; error prediction is made for each individual to obtain more reliable results, and the item parameters are not changed according to the groups to make the ability prediction independent from the items individuals (De Ayala & Santiago, 2017; De Mars, 2010; Embretson & Reise, 2000). IRT allows predicting the individual's abilities (θ) and item parameters by associating the individual's responses to the item with their ability level with item traits (Embretson & Reise, 2000). Since ability cannot be measured directly, IRT specifies the relationship between the observed success of individuals in the items and the unobservable traits or abilities which are presupposed to lie behind this success (Hambleton & Swaminathan, 1985). However, there are studies in the literature suggesting that IRT-based parameter predictions are more reliable because they create homogeneous latent classes (LCs) according to the response pattern in data in heterogeneous groups, meaning that the sample consists of latent subclasses (De Ayala & Santiago, 2017; Maij-de Meij, Kelderman, & Van der Flier, 2008; Yalçın, 2018). In Mixed-Item Response Theory (MixIRT) models emerging from the combined use of IRT and LC analysis, LCs or homogeneous subgroups are defined. Within each LC, the same measurement model is used, but different parameter estimates between the LCs are undertaken according to IRT (von Davier & Rost, 2017). MixIRT, discovered by Rost in the

1980s, has been widely used in the 2000s. Graded Response Model (GRM) is a logistic model with two parameters for polytomous data (Egberink, Meijer & Veldkamp, 2010). The slope parameter and the threshold parameter representing the number that is one less than the category number are predicted for each item (Embretson & Reise, 2000). The formula for the MixIRT model for GRM is as follows (Egberink et al., 2010; Finch & French, 2012):

$$P\left(U = 1 \middle| g,\ \theta_{i,g}\right) = \frac{e^{\left(a_{jg}\left(\theta_{ig} - b_{jg}\right)\right)}}{1 + e^{\left(a_{jg}\left(\theta_{ig} - b_{jg}\right)\right)}} \quad \text{(Equality 2)}$$

where "g: 1, 2, ..., G" represents LC membership, "b_{jg}" indicates the difficulty in the class for the item j, "a_{jg}" shows the in-class selectivity for the item j, and "θ_{ig}" refers to the level of latent ability measured in class for the individual i.

From the studies conducted with MixIRT models in the literature, it can be seen that MixIRT is used in achievement tests (Bolt, Cohen & Wollack, 2001; De Ayala & Santiago, 2017; Yalçın, 2018), Likert-type scales (Egberink et al., 2010; Ölmez & Cohen, 2018), personality questionnaires (Maij-de Meij et al., 2008), and to determine the response style (Eid & Zickar, 2007; Huang, 2016). The literature reveals that more studies were encountered regarding application of MixIRT in the achievement tests but there is a lack of studies on the use and introduction of MixIRT models in graded scales. In one study, MixPCM (Ölmez & Cohen, 2018) was used whereas in another research, Mixed-Graded Response Model (Mix-GRM) (Egberink et al., 2010) was applied. The current study presents an example of an application through real data and compares the MixGRM and GRM, which are among the MixIRT models for Likert-type items, are frequently used in measuring the latent traits of individuals, such as personality, interest, and attitude. In this context, this paper discusses the students' use of Information and Communication Technologies (ICT), which is considered to have a heterogeneous

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structure and constitute a necessary and indispensable part of their 21st century skills in relation to the literature (Partnership for 21st Century Learning, 2007; Trilling & Fadel, 2009).

The International Computer and Information Literacy Study (Fraillon, Ainley, Schulz, Friedman, & Gebhardt, 2014) reported that the relationship between the highest ICIL and the use of ICT was the strongest in Turkey. Besides, when ranked in terms of the participating countries interest and enjoyment of the use of ICT applications, Turkey is the country with the lowest score in terms of ICIL while it is the third country with the highest score in ICT (Fraillon et al., 2014). In the literature, the attitude toward ICT is related to the student's self-efficiency (Contreras 2004; Güzeller 2011; Rohatgi, Scherer & Hatlevik, 2016; Scherer, Rohatgi & Hatlevik, 2017) toward ICT and computer and information literacy (CIL) (Rohatgi et al., 2016). However, no significant relationship has been determined between the average CIL scores of the students participating in ICILS 2013 from Australia, Germany, Norway and the Czech Republic and having a positive attitude toward ICT, while the relationship was observed to be significant in a negative way in Germany (Gerick, Eickelmann & Bos, 2017). In this context, it seems that there may have been a paradox between some students' attitudes and achievements. In addition, according to the attitude-behavior theory of Fishbein and Ajzen (1975), beliefs regarding a subject lead to an attitude toward it. Beliefs arise from experiences related to the subject and when the beliefs about the subject are positive, the attitude will also be positive. Therefore, beliefs affect our attitude, and our attitude affects our behavior. When considered within the context of the use of information and communication technologies, as students first gain experience with computers, they develop certain beliefs about them (e.g., useful, coercive, entertaining). This makes their attitudes regarding computers to be positive or negative over time and this affects their behaviors toward computers over time; therefore, students can use computers or attempt to avoid using them (Gardner, Dukes and Discenza, 1993). For this reason, it is significant to examine students' attitudes toward ICT use. Moreover, while there are studies (Gerick et al., 2017; Rohatgi et al., 2016) conducted with data from ICILS about different countries, no studies have been encountered in the literature with data on Turkey. For the stated reasons, it is considered necessary to examine students in terms of liking to use ICT by dividing them into homogeneous classes and latent subgroups. This study aims to compare Mix-GRM with GRM in terms of model data-fit and parameters, and present an example of a MixGRM application on real data by separating students into homogeneous classes in terms of interest and enjoyment regarding the use of ICT. In this context, the following questions will be answered:

1. How does the model data fit the ICT scale for the students that participated in ICILS 2013 from Turkey according to application of MixGRM and GRM?

2. What are the traits of the latent groups according to the model that fits with MixGRM? How are the students distributed in terms of the item response categories for the LCs and the whole group?

3. What are the slope and threshold parameters of the liking ICT use scale according to MixGRM and GRM?

Method

Research Model

This study is basic research since it contributes to the development of theory in terms of the comparison of the parameters predicted according to GRM and MixGRM with

model data-fit results and including application of Mix-GRM on actual data.

Data Source

The research was conducted through the data from ICILS using a two-stage stratified sampling method applied to eighth-grade students participating from Turkey in 2013. The data was obtained from the ICILS webpage (https://icils.acer.org/). In this study, from a total of 2540 students that participated in ICILS 2013, analyses were undertaken on the data of a total of 2356 students, 1214 male and 1142 female, after missing data were deleted. The data source in the study consists of students' responses to a Likert-type scale of 11 items that measures students' interest in and enjoyment of ICT within the scope of ICILS 2013.

ICILS 2013, was a comprehensive study implemented out by the International Association for the Evaluation of Educational Achievement (IEA) for the purpose of examining students' ICIL levels. ICILS aims to determine the level of computer and information literacy skills and the factors associated with these skills to support young people's digital age participation capacities in a modern society (Fraillon, Ainley & Schulz, 2013). The participants in ICILS 2013 included 60000 eighth-grade students, 35000 teachers and 3300 schools from 21 education systems of the following 19 countries: Australia, Canada, Chile, Croatia, Czech Republic, Denmark, Germany, Hong Kong, Korea, Lithuania, Netherlands, Norway, Poland, Russian Federation, Slovak Republic, Slovenia, Switzerland, Thailand, and Turkey (IEA, 2014).

For the data collection of the study, a national questionnaire was used to obtain information about the education system, and computer and information technology test, student questionnaire, teacher questionnaire, school administrator questionnaire, coordinator questionnaire were employed for international students. In this study, students' gender, computer and information literacy achievement scores and liking to use ICT scale were used. Computer and information literacy achievement scores were converted to a scale with an average of 500 and a standard deviation of 100. Four competence levels for CIL were defined. Level 1 was defined between 407 and 491 points; Level 2 was between 492 and 576 points; Level 3 between 577 and 661 points; and Level 4 for 661 points and above. Students in Level 1 can use traditional software instructions and are familiar with the basic layout rules of electronic documentation. Points below 407 indicate a rather low literacy level even below the targeted Level 1. The average credibility of the liking to use ICT scale for national samples is .81, the factor loadings range from .74 to .86 and having higher points than the scale is interpreted as higher interest and like for ICT (Fraillon, Schulz, Friedman, Ainley & Gebhardt, 2015).

Data Analysis

Firstly, a confirmatory factor analysis (CFA) was conducted in the Mplus-8 program to view the assumption of the one-dimensional of the scale measuring students' interest and enjoyment in using ICT. Information regarding the factor loadings of the items as a result of the analyses are presented in Table 1.

As shown in Table 1, the factor loadings as a result of the CFA were in the range of .678 and .805 and were significant. When the fit indexes obtained from the one-dimensional model were examined, the model appeared to have a good level of fit ($\chi^2_{(44)}$= 1329.318, p< .01, RMSEA: .11, CFI: .94, TLI: .93). For the reliability of the scale, the Cronbach's Alpha Coefficient was calculated as .89. In this context, it

can be stated that the scale is valid and reliable in measuring the interest and enjoyment of students to use ICT.

Table 1. *The CFA results of the students' interest and enjoyment in using ICT scale*

Items	Estimate	S.E	Est./S.E.
i1	0.698	0.013	54.883*
i2	0.729	0.011	65.126*
i3	0.764	0.012	64.741*
i4	0.805	0.009	92.420*
i5	0.678	0.013	52.627*
i6	0.774	0.010	76.385*
i7	0.757	0.010	75.334*
i8	0.748	0.013	57.640*
i9	0.769	0.010	74.105*
i10	0.743	0.011	67.641*
i11	0.717	0.013	53.762*

For the first sub-goal of the study, a GRM analysis and five MixGRM analyses from the model with one LC to the model with five LCs were practised out in the Mplus-8 program to determine which model fit the data better. For the second question of the study, the index scores regarding the students' gender, computer and information literacy achievement points and the state of liking using ICT were used to determine the characteristics of the latent groups according to the model that fit the liking of using ICT scale. In addition, the distribution of the students according to the response categories were examined and presented in graph format. For the object of finding the answer to the third question of the study, the parameter values were interpreted by presenting according to the model that fits the liking using ICT scale and GRM.

Results

Within the scope of the first purpose of the research, different models were tried in order to determine which model offered the better fit of the data obtained from ICT scale. The results regarding the model fit are presented in Table 2.

Table 2. *The results of goodness of fit analyses for the investigated models*

Models	AIC	BIC	Entropy
GRM	46250.236	46503.883	-
MixGRM-LC1	46250.249	46503.897	-
MixGRM-LC2	44420.699	44933.759	0.659
MixGRM-LC3	43936.068	44708.541	0.704
MixGRM-LC4	43609.700	44641.585	0.704
MixGRM-LC5	43449.049	44740.346	0.742

As shown in Table 2, when the results of the MixGRM- and GRM-based model data-fit were compared, the model with the best fit for the Bayesian information criterion (BIC) value was MixGRM with four LCs. The entropy value of this model also indicates that the accuracy of the classification was at a good level (Clark, 2010).

Information presented in Table 3 shows the latent group traits according to the best fitting model and reveals the group according to Mix-GRM with four LCs, which was the second sub-goal of the research.

As shown in Table 3, according to MixGRM with four LCs, 48% of the students were in the first LC (LC1), 35% in the second LC (LC2), 9% in the third LC (LC3), and 8% in the

last LC (LC4). When the computer and information literacy score averages of the students were examined, the students with the highest average were in LC1 and the students with the lowest average were in LC4. This was also seen when the indexes were examined in terms of the average of interest and enjoyment regarding the use of ICT. It can be stated that students who were more interested in using ICT were in LC1, and those who less liked or did not like at all were mostly in LC4. While the students in LC1 and LC2 had higher scores in CIL than the average of Turkey (361), the students in the LC3 and LC4 groups had scores that were lower than the average in Turkey. Moreover, when the distribution of the students in the latent classes was examined in terms of sex, it was seen that the rates were almost equal in all the LCs except for LC4, in which 32% were male while 68% were female. According to the findings concerning the latent classes, the students in LC1 had a higher level of CIL and liked to use ICT. LC2 to LC4 students had a gradually decreasing literacy score and level of enjoyment in the use of ICT.

Table 3. *Information regarding the Mix-GRM-based model with four LCs*

	LC1	LC2	LC3	LC4
Student rate (%)	48	35	9	8
CIL score averages ($\bar{x}$)	375.57	371.90	350.14	307.61
Students' interest and enjoyment to ICT ($\bar{x}$)	57.26	48.92	45.76	42.74
Gender (Female/Male) (frequency)	563/560	405/420	115/108	59/126

The distribution of the response categories of the students according to the LCs and the whole group is presented in Figure 1.
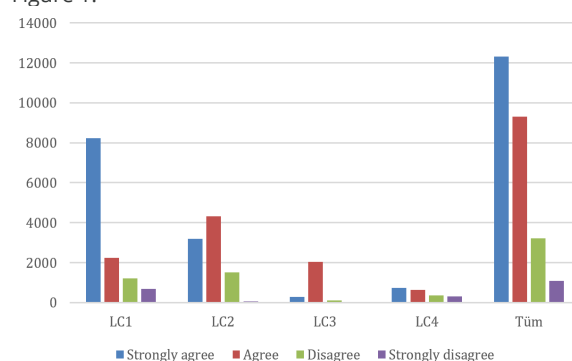

Figure 1. Distribution of response categories according to LCs and the whole group

The students in LC1 had higher responses in the "strongly agree" and "agree" categories than the other LCs (Figure 1). This class can be called the acquiescence response class because the rate of inclusion in the first positive categories was rather higher than the other classes. On the other hand, the "agree" and "disagree" categories in LC2 were in higher ratios than the other classes. Therefore, this class can be called the general class or midpoint in terms of response style. While the category "agree" was dominant in LC3, no dominant category emerged in LC4. When the frequencies in the categories of the students in the whole group were examined, the students usually marked "Strongly agree" and "agree" categories; therefore, this group can be considered as the acquiescence response style.

In the context of the third sub-goal of the study, the results of the analysis conducted to compare the slope and threshold parameters of liking use of ICT scale according to MixGRM and GRM are presented below. First, the slope parameter values predicted according to these models are given in Table 4.
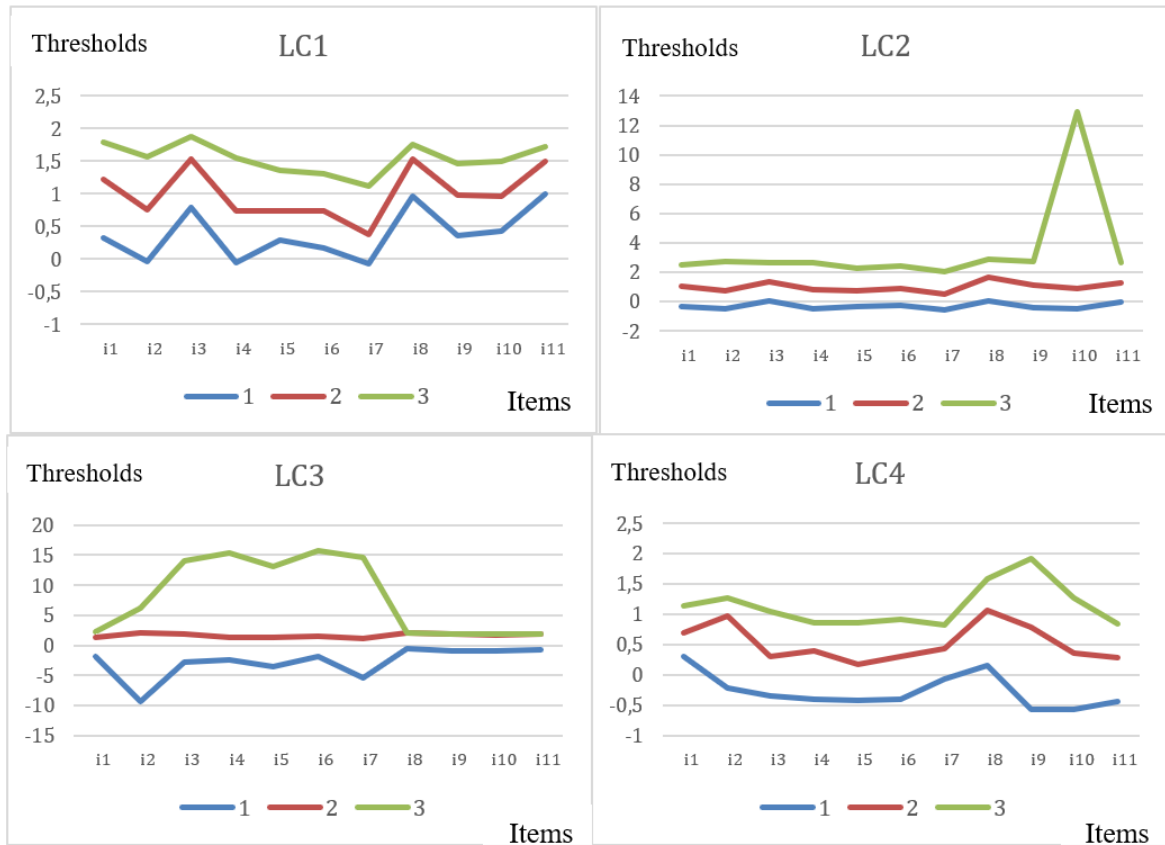
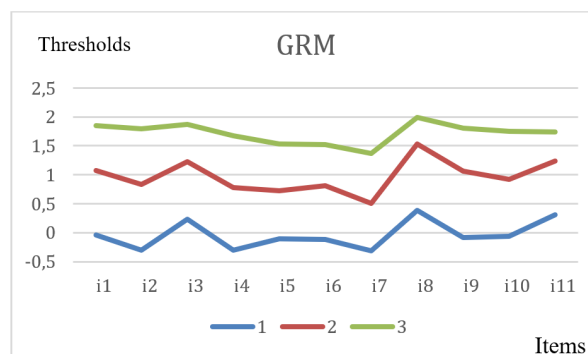**Figure 2.** Distribution of the threshold parameter values for LC1, LC2, LC3, LC4

Figure 3. Distribution of the threshold parameter values for GRM

Table 4. *The slope parameter values according to different models*

Slope parameter (a)	MixGRM				GRM
	LC1	LC2	LC3	LC4	
i1	0.677	0.775	-0.338*	0.702	0.715
i2	0.801	0.713	-0.871	0.721	0.741
i3	0.712	0.804	-0.523*	0.874	0.770
i4	0.849	0.862	-0.233*	0.711	0.816
i5	0.606	0.740	-0.600	0.780	0.684
i6	0.806	0.832	-0.084*	0.717	0.791
i7	0.860	0.828	-0.425	0.553	0.763
i8	0.904	0.675	0.987	-0.002*	0.746
i9	0.887	0.735	0.984	-0.076*	0.770
i10	0.880	0.674	0.993	-0.141*	0.742
i11	0.857	0.665	1.000	-0.027*	0.714
Average	0.804	0.755	0.081	0.437	0.750

*$p < .05$

When the findings from the item parameters of the LCs in Table 4 were evaluated, it was seen that the highest slope parameter average was in LC1 and the lowest value was in LC3. The average of the slope parameters predicted by GRM was very close to the average of the slope parameters in LC2. The first seven items in LC3 and items 8 to 11 in LC4 had a negative slope parameter value. While items 2, 5 and 7 which had a negative slope value in LC3 were not significant, none of the items with a negative slope value in LC4 was significant. When these items were examined in detail, it was found that the first seven items measured the state of students' finding computers important and entertaining, and their interest in computers, while items 8 to 11 measured students' use of computers, such as doing new things on the computer, using computers for problem solving, and searching for new ways to solve a problem on a computer. The correlations between GRM and the slope parameters predicted for each LC are presented in Table 5.

As shown in Table 5, when the correlations between the slope parameters predicted by GRM and the slope parameters in the LCs were examined, there was only a high level of relationship between LC2 and GRM. The other corre-

lation values were not significant. The distribution of the threshold parameter values predicted according to different models is presented in Figures 2 and Figure 3.

Table 5. *Correlation between GRM and slope parameters predicted according to LCs*

GRM	LC1	LC2	LC3	LC4
	.314	.651*	.077	.050

As shown in Figures 2 and 3, in all latent classes and GRM, the threshold values gradually increased from "completely agree (1)" to "disagree (4)" for all items. The threshold values indicated where responding to a category was more likely than the previous category. In addition, some threshold values were observed to be negative. This can be interpreted as students' having a lower level of attitude toward the related items. Concerning the threshold values in the LCs (LC1: 0.978, LC2: 1.41, LC3: 2.36, LC4: 0.47; DTM: 0.884), the lowest average was in LC4 and the highest was in LC3. The correlations between the and the threshold parameters predicted for each LC are presented in Table 6.

Table 6. *Correlation between the threshold parameters predicted according to GRM and LCs*

GRM	LC1	LC2	LC3	LC4
	.945**	.976**	.900**	.897**

** *p*< .05

When the correlations between GRM-predicted thresholds and LC thresholds were examined, it was found that all the correlations were very high and significant, and that the highest correlation was in LC2. In this context, it can be stated that the estimation by MixGRM had a considerable effect on the slope parameters of the items but not on the threshold parameters.

Discussion, Results and Suggestions

This study aimed to demonstrate the application example of MixGRM on real data by separating students into homogeneous classes with regard to enjoying use of ICT and to compare MixGRM with GRM in terms of model data-fit and parameters. Concerning the goodness of fit results of the GRM- and MixGRM-based models, the model that best fit the data according to the BIC value was MixGRM with four LCs. When the students' average CIL scores were examined, it was seen that the students with the highest average CIL were in LC1, while those with the lowest average were in LC4. This situation was also observed when the average scores in enjoying use of ICT were analyzed. Besides, the distribution of the students in the LCs according to gender revealed that the results were very similar in all LCs except for LC4. According to the findings, LC1 comprised students that both had higher rates of CIL and enjoyed using ICT. Both the students' literacy scores and the state of enjoying the use of ICT gradually decreased from LC2 to LC4. In this context, it can be considered that the students in LC4 were those who had the lowest rate of CIL and did not enjoy using ICT or enjoyed it very little. This study demonstrated the relationships between enjoying ICT use and CIL in a linear positive way. In the literature, parallel to this finding, attitudes toward ICT were related to self-efficacy in ICT (Contreras 2004; Güzeller 2011; Rohatgi et al., 2016; Scherer et al., 2017) and CIL (Rohatgi et al., 2016). In addition, self-efficacy in basic ICT skills and CIL achievement were related positively, whereas there was a negative relationship between self-efficacy in advanced ICT skills and CIL (Rohatgi et al., 2016). However, in another study, while the relationship was significant in a negative way only in one country, there was no significant relationship between students' CIL average and having a positive attitude toward ICT in other countries (Gerick et al., 2017). In this context, it can be stated that there are degrees of

competence perceptions of individuals, and the relations between attitude and achievement could be positive, as well as paradoxical. Therefore, as in this study, it is suggested that the variables that are to be used in related studies, such as attitude, self-efficacy and achievement should be examined by dividing them into sub-categories.

According to the distribution of the students in the response categories, LC1 could be named as the acquiescence response category and LC2 as the general class or midpoint response style. Previous researchers (Eid & Zickar, 2007; Huang, 2016) recommended the use of MixIRT to determine response styles. Furthermore, since different response styles may have different response patterns, MixIRT models can be used to classify individuals according to their response styles (Huang, 2016).

Concerning the item parameters in the LCs, the highest average of the slope parameter was in LC1 and the lowest was in LC3. It was observed that the average slope parameter predicted according to GRM was very close to that found in LC2. When the correlations between the slope parameters predicted according to GRM and the slope parameters in the LCs were examined, it the only significant relationship at a high level was observed between LC2 and GRM. In addition, seven items that measured students' finding computer important and entertaining, and being interested in computers were negative discriminations for students in LC3, while the items in which students used computers in ways such as doing new things on the computer, using computers for problem solving purposes, and searching for new ways to solve a problem on the computer were classified as negative separators but were not significant for students in LC4. Considering the fact that the students in this LC had the lowest CIL score, this situation can be interpreted as the items measuring such high-level tasks not working at all for this group.

When the threshold averages of LCs were examined, the lowest average was found in LC4 and the highest average in LC3. All correlations between the threshold values predicted according to GRM and the threshold values in LCs were very high and significant, but the highest relation was found with LC2. Furthermore, the threshold values of the items regarding GRM prediction were quite close to the results in the ICILS 2013 technical report (Fraillon et al., 2015). It was concluded that making predictions according to MixGRM significantly affected the slope parameters of the items but did not cause significant differences in the threshold parameters. However, this may have occurred because the threshold value of the items had an influence on the response pattern of individuals. For this reason, it is recommended that this situation is tested under different simulative and actual data conditions.

The obtained findings show that MixIRT models can be selected for studies that require a focus on different subpopulations, such as reducing heterogeneity in the data set and determining the response style, different socio-economic levels, high attitude-low achievement or low attitude-high achievement. Researchers can use MixIRT models in many fields from career development to personality tests. Moreover, when students' CIL scores are taken into consideration, even those included in the group with the highest score are below Level 1 according to the international score classes, which reveals that Turkish students are not yet prepared for life in the digital age in terms of the 21st century knowledge and media skills.

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The Siyavula Case: Digital, Collaborative Text-Book Authoring to Address Educational Disadvantage and Resource Shortage in South African Schools

Sarah Lambert*

Abstract

Siyavula is known as a pioneer developer of high-quality free digital maths and science textbooks to address resource gaps and disadvantage in South African schools. This case study identifies the success factors which could be replicated in other contexts. Siyavula has developed expertise in digital developing, editing and improving maths and science workbooks and teachers' guides and distributing them in multiple digital and mobile formats for free. In 2013 the government took the free texts and sponsored the printing and distribution of c500K copies of Grade 4-6 titles, saving the government approximately USD$83.5 Million for each of the 12 books (student workbook and teacher guide in both English and Afrikaans). The collaborative authoring system is identified as instrumental to the success of the project to address under-resourced schools, through a combination of personal (attitudinal), technical (online systems) and social resources (volunteers and stakeholders). Siyavula leaves a legacy of multi-stakeholder volunteer text-books sprints where an intense face-to-face experience provides the ground-work for constructive online authoring inclusive of diverse stakeholder input across different roles and ranks. Collaborative authoring advances curriculum and pedagogy sharing, expertise and capacity building. Collaborative authoring systems are found to have potential in many under-resourced school contexts not only for school texts, but also for early reading, multi-lingual and culturally appropriate book adaptations.

Keywords: Stem, Textbooks, Disadvantaged Schools, Oer, Social Justice, Digital Resources, Mobile Friendly, Online Publishing

Introduction

Siyavula is known as a pioneer developer of high-quality free digital and print maths and science textbooks for South African schools. The work began in 2002 in response to personal interactions with determined kids from poor rural schools at a Science Fair seeking to overcome a lack of resources and science expertise in the schools including a lack of science textbooks.

By 2013 Siyavula had not only created a digital suite of Open Educational Resource (OER) texts downloaded by hundreds of thousands of learners, they had also built a relationship with government and had Grades 4-6 books printed and distributed nationally at no cost to schools. This benefitted a cohort of learners who would otherwise have had no textbook due to curriculum shifts and other external issues. The use of OER rather than commercial text also saved the Government millions of Rand, as in addition to being free to the end-user, OER texts have no copyright restrictions limiting copying and distribution. OER texts are designed to be shared and modified by others as part of an effort to democratise access to knowledge and learning.

Siyavula developed a private-public partnership business model with philanthropic funds and voluntary labour covering textbook authoring, which reduced print and distribution costs of texts to approximately 14.4% of a similar commercial offering. They had developed a "one book, multiple formats" delivery system which allowed learners to download and learn maths and science topics with the most basic of "feature phone" and also got these resources "Z rated" so that the downloads were free – an important strategy in a context of high data charges which are a barrier to downloads. Siyavula was therefore able to address a lack of access to good quality maths and science resources which is a problem in many countries world-wide. Provision of free resources is a strategy to address the larger global problem of de-

clining maths and science foundation skills, which tends to have a greater impact on poorer or more disadvantaged schools. Low-resourced schools tend to be caught in a downward spiral of fewer students doing higher levels of maths and sciences leading to fewer maths and science classes leading to fewer skilled and enthusiastic teaches. These factors all combine so that disadvantaged schools inadvertently perpetuate inequality of life chances by graduating whole cohorts who can never apply for let alone succeed in post-secondary education and high-status courses such as medicine and engineering (Mestan & Harvey, 2013).

This South African case study offers insights of interest globally for a range of low-resourced school contexts, as keeping students from all backgrounds enthusiastic about and engaged with foundation science, technology, engineering and maths (STEM) learning is a strategic equity priority in many jurisdictions.

Fundamentally, this case study aims to unpick the history and development of Siyavula and OER textbooks in South Africa so that others may learn from the experience. It focusses on how collaborative authoring processes enabled OER textbooks to be developed, and how South African school students were enabled by these.

The case study analysis identifies which of the success factors are unique to a particular moment in time in South Africa, and which might be replicated in other contexts. The study also probes for student uptake, impact and outcomes. It therefore offers a new perspective as well as a more comprehensive case write up than the few existing publications which look at early evaluations (Siyavula: Building Communities to Support Teacher Use, Localization and Sharing of OER, 2009), publication costs (Goodier, 2017), business models (Stacey, 2017), and teacher perceptions and usage (Pitt & Beckett, 2014).

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Background

Although Siyavula was founded as a social enterprise in 2012, by then the group had ten years' experience in collaborative digital developing, editing and improving maths and science workbooks and teachers' guides and distributing them in various digital forms for free.

Siyavula has developed a digital catalogue of OER STEM textbooks and other online practice resources providing students with quiz and feedback sequences. For each book in the grades 4-6 and 10-12 series there was both an OER student and teacher guide book, and each was printed in both English and Afrikaans.

By 2013 Siyavula had proved it was possible to transform learning resource provision to enable more equitable learning opportunities in South Africa – by using a blend of private-public-philanthropic resources and outputting using a blend of digital and print formats. But the political and policy context shifted before the exercise could be replicated let alone expanded within South Africa. However, due to a 2017 grant from Google, Siyavula has been able to migrate its successful OER concept-mapping and textbook work to neighbouring African nations, starting with Nigeria (Khan, 2017).

Parallel to the work on OER texts, Siyavula continues to develop low-cost but commercial digital learning tools for maths and science, and sponsors cover costs so the poorest school students can still benefit.

South Africa has around 25,000 schools and 12 million learners in the system. There are quintiles in terms of performance with Quintile 1 schools being severely under-resourced, ill-equipped and dysfunctional, and Quintile 5 schools being the top-end schools.

Mark notes, "Most of the (philanthropic) funders work in schools in quintiles 2-4 bracket, they probably won't have either running water or electricity. Probably they have pit latrines. The 350 schools who are sponsored for access to our practice service fall into this bracket - some of them are urban, some of them are rural. In quintile 5, the top tier, the independent schools, we've got about 75-80 schools using our subscription service and they pay us, but they will ask for the parents to pay for it."

Many of the processes, technologies and partnerships Siyavula developed continue to hold promise for future change in South Africa and beyond.

In particular, their pioneering collaborative authoring systems and their business models which support sustainable social enterprises stand out as having long-lasting value. In recent years there has been an interest in how to sustain open education projects. Other OER projects around the world have developed similar methods such as textbook sprints and blended business models to ensure the sustainability of their enterprises which have a social purpose. A recent book about open business models used many examples including Siyavula's organic development from experiment to grant to social enterprise (Stacey, 2017).

However until now the full details of Siyavula's success factors have not been published. This unique case study offers rich details about the personal, technical and social resources that underpinned Siyavula's success and legacy. If also offers a discussion of the potential of Siyavula's model and collaborative online systems for other contexts including for bi-lingual foundational reading skills and bi-lingual classroom instruction.

Methodology

Case studies are a regularly used form of empirical enquiry used in educational research, as they allow "how" questions to be answered by investigating complex contemporary phenomenon "in depth and within its real-world context" (Yin, 2009). The research question guiding the data analysis and write up of the case was: how did Siyavula develop an equitable and sustainable learning resource development system that delivered value to individual learners, schools and government?

Case study methodology was followed, focussing on the history of a single organisation as a unique case that can offer unique insights. The timeframe is 2002 – 2017 and the context is South Africa. The primary data was a set of records provided by Siyavula including a verbal account of the history of Siyavula and OER in South Africa from the perspective of Mark Horner and Megan Beckett - two key and long-term Siyavula staff-members who had different roles and foci during the period as the following section explains. Using Google docs as a space to share documents and data from Siyavula's history, Mark and Megan were also able to provide clarifications on the materials in response to questions from the researcher. Human Research Ethics Committee approval was gained from Deakin University to conduct the research, including for naming the participants with their approval in the case study and for sharing the primary data sources in an open-data repository for the benefit of other researchers and future research (Lambert, 2018a).

Mark Horner and Megan Beckett

Mark Horner is CEO and Director of Siyavula and physics PhD graduate of the University of Cape Town (UCT). Mark led the first exploratory (2002-2007) Free High School texts development with other UCT colleagues after meeting the township kids at the Science Fair. Mark has led all subsequent work firstly funded by the Shuttleworth Foundation and later as Siyavula spun out of that structure as a separate company.

At the time of writing, Megan Beckett was responsible for Learning Research and Analytics at Siyavula. Megan joined Siyavula in 2011 and led the development of the Natural and Life Science textbooks, starting with the year 4-6 curricula which was printed by the South African Government. Megan was instrumental in the iterative development and refinement of new processes of community engagement in the development of quality, curriculum aligned texts. This involved physical and virtual contributions from teachers, curriculum experts, technical experts, students and government officials. Megan left Siyavula in 2018 to launch her own consultancy company.

Figure 1. Megan Beckett and Mark Horner at Siyavula office, March 2017 (CC-BY Sarah Lambert)

Data Analysis

The case study analysis and write up was undertaken by the author in the light of research developments, interests and insights which have emerged from a related PhD study in the area of open education as social justice actions (Lambert, 2018b). The case study was influenced by an interest in research methodologies that seek to identify success factors with transferability to other contexts, and insight into the use of social enterprises to sustain open education work for the benefit of low-resourced communities.

The data that the author has relied on to address the research question and interests are the components of Mark and Megan's verbal accounts focussed on key developments and events leading to the 2013 milestone achievement and the reflections on the long-term value of developed processes in the light of the contextual changes. Accordingly, some of the more technical information captured in the original data eg xml pipelines to multiple publishing formats are not discussed in detail. Researchers with complementary research interests in the Siyavula case are encouraged to review and use the original data logs (Lambert, 2018a) to further their own research.

The case has been written up using time as an organising device. The key developments and events appear under a heading of the year in which they occurred. The sections are enriched with direct quotes from Mark and Megan to provide both facts and the tone or feeling of the events. The aim is to let Mark and Megan describe key events in their own words wherever possible so that their considerable contribution is not overshadowed nor skewed by the researcher or the case write-up. Each year section ends with a discussion of the case themes, identification of unique versus replicatable actions and events, and comparison with other recent similar work. Next, an overview of all the case themes is provided classified by Warschauer's dimensions for socially inclusive uses of ICT: Technical (Physical/digital) resources, Personal resources (called "Human" by Warschauer, and here extended to include attitudinal resources), and Social resources (Warschauer, 2003).

The case concludes with a discussion of the legacy and potential for future work both within and beyond South Africa.

The Siyavula Case: Success Factors that Made Excellent Maths and Science Learning Accessible and Affordable in South Africa

2002 University of Cape Town Science Fairs

Mark Horner was one of the graduate students at the University of Cape Town who ran physics demonstrations at community-based Science fairs which brought him and colleagues into contact with "barefoot" physics students learning without textbooks or teacher expertise. Mark said this experience led to the development of a "project started by graduate students called Free High School Science Texts to collaboratively author text books."

"We had had kids come to our Physics demonstration at a Science fair, (they'd) seen something that was in the curriculum, they'd come back the next day with a notebook and a pen, and they'd ask if they could write everything down. They were often from a really poor rural school, they said they didn't have textbooks and their teacher wasn't going to be able to teach it to them, but they knew it would be in the grade 12 exam at the end of the year. So they'd write everything down. These are barefoot kids, grey flannels and a white shirt, but barefoot."

With the back-drop of the Science Fair, what stands out from Mark's account as the catalyst for action was the personal interaction with individuals – with those barefoot kids from those poor rural towns. And it wasn't just a matter of feeling sorry for them. I suggest from Mark's account there is also a sense of being impressed with these kids' determination to succeed. Not only did these kids make an effort to come to the science fair, they also knew enough about the curriculum and the end of year examinations to know what knowledge they were missing. This motivated them to come back for a second day and take down all the notes that they could. This is an excellent example of learner agency - the ability to identify and solve their own problems to meet their own goals (Archer, 1996, 2003; Case, 2013). When learners are this motivated and capable, it is reasonable to think that effort to give them assistance through provision of a decent textbook might actually make a difference.

Equity research calls this working from a "strengths perspective." Strengths approaches continues to gain ground with equity researchers and practitioners in contrast to a "deficits approach" which has been shown to be problematic over the last decade (Devlin, 2012; McKay & Devlin, 2015; Mountford-Zimdars et al., 2015; O'Shea, 2016; Southgate & Bennett, 2016). A "deficits approach" to helping disadvantaged learners stems from the perspective that learners are lacking in ability, motivation, family support and/or community role-models. This tends to perpetuate low expectations and remedial approaches which not only re-inforces disadvantage but also limits the effectiveness of the work (Atal, 1997; Munns, Sawyer, & Cole, 2013; Thomson, 2002).

I would argue that Mark and colleagues' early engagement with these poor but resourceful community learners at the Science Fair not only personalised a group that are often reduced to a stereotype or impersonal cliché. But it also seeded a strengths-based approach based on respect and faith in learners and is a core success factor that underscored this particular catalysing event. The themes of personal engagement with community and of learner strengths and agency are important that will appear again and are threaded through the case study.

2002-2007: Free High School Science Texts (FHSST) project

Over a period of 5 years, Mark and a tech savvy group of physics graduate students volunteered their labour to collaboratively develop free OER maths and science textbooks for school grades 10-12. Because of their experience in open-source software community, they were aware of the early alternatives to copyright ie licences that allowed sharing. They would ultimately adopt what has become an international standard: the Creative Commons licencing system (see https://creativecommons.org/).

5 years is a long time to maintain momentum and voluntary commitment for such a project. This may be a unique or rare occurrence compared with other projects in other parts of the world which rely on grant funding to develop free resources (Lambert, 2015) or paid post-graduate students working on university level materials (Hodgkinson-Williams & Paskevicius, 2012).

The ability to keep the project going over 5 years seems to be related to the importance the graduate students placed on the work, and the fact that a whole group was involved. While there may have been a small core authoring team, at final count there were 40-50 contributors on each textbook. So too were strong computing science skills needed to manage the technical production. Considering the well documented challenges with collaborative work, the success of this sustained 5 year effort might be linked to the

collaborative authoring strategy - working within strong and functional existing collegial networks with strong existing technical skills, and on the basis of writing subject matter which is well known to you.

Their technical background and exposure to open-source software also shaped the approach. They side-stepped a debate over the definitions of the terms "free" and "open" (the latter connected to specifics of legal licencing options) by pragmatically focussing more on educational equality than making a commitment to "openness".

"The project has this extremely unimaginative name, just because of the complexities of dealing with people in the free software movement ... And we are very pragmatic... Eventually, they didn't care if you used the word free, so we went with the Free High School Science Texts, a descriptive and pragmatic and boring name. We called it an open text at the start, and they were like, "hmmmm is it the right kind of open?" And we were like, we don't really care. The need we were trying to address is kids who don't have access to textbooks."

During this time many people and organisations invested time and resources into developing coherent series of free or open educational resources (OER) which – like FHSST – would go on to be re-purposed and re-used for different cohorts and purposes, such as the Saylor.org, OpenStax textbooks or MIT Opencourseware content forming the basis of many early MOOCs. Repositories designed to share or globally distribute free learning resources like MERLOT (more for teachers) and iTunesU (more for the individual learner) were also emerging and gaining momentum. Unlike these examples which are mostly authored by wage-earning higher education earners, Siyavula stands out for the degree to which they were able to harness volunteer graduate student expertise. There is some common ground however – they have shown over time that investing in quality series of curriculum aligned OER is a good investment which can bear fruit many years after the original effort.

2007: Shuttleworth Foundation and the Cape Town Declaration of Open Education

In 2007 a meeting of OER leaders organised by the Shuttleworth Foundation participants authored and signed the Cape Town Declaration of Open Education. Concurrently, a project was launched that hired Mark to expand the FHSST project. The project was called "Siyavula" and it was ambitious. The goal was to collaboratively author OER school texts for all grades, and all subjects. Siyavula means "we are opening". Siyavula's mission is to make excellent maths and science learning accessible and affordable for all. During this period, it also aspired to transform publishing models as a way to increase equitable educational access.

2007-09: Siyavula Project acquires pre-existing textbook content

During this period Siyavula purchased pre-existing textbook content for Grade 0 (eg Kindergarten) to Grade 9 for all Learning Areas, in both English and Afrikaans. The idea was always to build a community of users around the content, but during this period Mark realised there were 2 ways this could be done – collaboratively author from scratch, or collaboratively modify based on some existing content. The latter choice of strategy to engage teachers to review and modify a base set of resources addressed both the desire to scale up the project quickly and to also deal with the identified problem of cultural resistance for sharing maths and science teaching resources in South Africa.

"If you bring a community together and you ask them to share their resources, particularly in a unhealthy and very critical environment like we do in South Africa for teachers then they are very scared to share, because it can expose their competence or lack thereof, they can feel like they are gonna be attacked, they can feel like it's a form of assessment. So there's a lot of issues around the sharing."
"So our theory of change was that we could bring this content, bring communities or groups of teachers together, to use this as non-threatening content that they could adapt and enhance. You've probably seen this, if somebody takes a resource and they make a tiny tweak, they fix a typo in a book, and it's like they've written the whole book all of a sudden, a sense of ownership."

"Ownership" by engaging in authorship of resources is important, as it tends to lead to increased awareness, advocacy and use of the resource. Following this logic, a point of difference for Siyavula emerged - the more authors the greater the take-up and the greater the return on that time and resource investment.

Also, these quotes show that by this point Siyavula had conceptualised of their project as more than a textbook project, and had developed a "theory of change" in line with many other resource-constrained and poor-performing education systems (Daniel, 2014; Laurillard, 2016; Patru & Balaji, 2016). They wanted to improve teacher skills and pedagogy at the same time as improving the actual resources.

2009-2010: Mass staff training to modify draft textbook content using Connexions platform

During this period, Siyavula put the acquired content on the Connexions online textbook platform and attempted to train 1000 teachers and curriculum advisors in online authoring, many located in remote and rural locations. This was a major undertaking involving the use of portable internet servers and wifi networks and a suite of 100 laptops. Despite best efforts – it was not successful.

Mark notes - "I love the Connexions team, we've worked with them for many years, but their website is un-usable by teachers. It's too complicated, we tried, we wrote manuals, we taught them basic xml, but as soon as people see mark-up languages they're freaking out. It didn't work. They want to use Word."

The original materials are still on the original Connexions platform and Megan notes that "there was some uptake and adaptation of the content by teachers, but not to the scale that was initially envisioned nor in line with the number of teachers actually trained."

This tough reality check about what technological tools non-technical experts are prepared to accept and use was a lesson learnt the hard way by others as well as Siyavula. For example, wiki authoring never made it to the mainstream despite many efforts as Wikipedia rose to prominence and innovative educators began to embed it in lessons and assessment. Lack of technical skills to modify and localise OER has been a real barrier to OER adoption across the board (Wiley, Bliss, & McEwan, 2014). There is a tendency to look at IT training as a matter of breaking down tasks required of the software, and making each of them as simple as possible. In reality users want to invest time in learning to better use the tools they use everyday, across numerous tasks and domain rather than spending time on specialist tools that have high skills barriers to entry, and which they will not in reality use very often. This is a factor with other educational technologies such as LMS and ePortfolio tools, which students typically do not use once in the workforce.

2010: Public Sector Strike and an early text-book sprint

In 2010 there was a major national Public Sector Strike in South Africa over claims for reasonable wage and housing allowances. The striking public servants including teachers and nurses had been campaigning for many years but were resolved to strike because after "the government's lavish expenditure on the 2010 soccer world cup, strikers found it difficult to believe that government could not meet their demands." (Ceruti, 2011). The large and powerful teachers' union went out on strike early, and stuck it out so that kids were without teachers for about a month. The Department of Education seized upon the openly licenced FHSST texts to mitigate the loss of teachers and teaching time for year 12 students approaching final exams with no teachers.

"So they called, literally phoned one day to ask can they print this stuff for the whole country, to try and mitigate the effects of the strike… This was the trigger for them to consider these open resources as something that they could use…" While the printing of books turned out to be beyond the Government's budget at that time, the crisis surfaced extra voluntary labour to edit and improve the digital versions. As Mark notes, "So we did some things that were quite interesting. We edited all 6 books in the space of one week using 100 volunteers collaborating online. They said can you just do another proof-read, and we said, well, that's a few thousand pages of content. We got Mark Shuttleworth to put a call out on his blog, for people to help us. And we got people with a Masters or PhD to help proof-read the content. 100 people who are prepared to proof-read a few chapters, can get through a lot of content very quickly because they're distributed, and it's all happening online simultaneously, with online annotation." The public sector strike - a unique point-in-time and place event was critical to Siyavula's development as they were able to gain traction with the government regarding OER texts, and yet is not something that can be manufactured. As Mark notes, "This is only relevant because some people would like us to be a success story that can be replicated… there were a lot of people who thought what we did could be replicated but there were a lot of factors that were way out of our control."

It also shows the power and goodwill of volunteers to step-up when needed to edit 6 books in a week via online collaboration. What is less clear is if these (or other) volunteers would have put in the time if they thought the books would not be printed. Volunteer motivation to see a concrete output from their work can be first seen in this early 'book-sprint' and will also emerge later in the case.
2011: new working relationship with the Government
The FHSST texts were curriculum aligned to the 2005 curriculum statement and naturally, over time, the curricula was reviewed and changed. The new 2011 curriculum was tightly defined with regard to topic teaching sequence and timing. The new curriculum was both more supportive and more prescriptive of what was to be taught. This was because teachers' skills in translating the older outcomes based curriculum materials to actual lesson plans was not considered to be sufficient in practice due to lacks in staff training and development. The new curriculum meant textbook providers had to meet stricter government requirements regarding both the format and the content. The new curriculum made the FHSST redundant and so in 2011 Siyavula took their Grade 10 maths and Science books, aligned them to the new curriculum and got them approved by what had become the Department of Basic Education (DBE)

This phase of the case signalled a developing of a productive working relationship with the government which had formed during the public strike action period.

Importantly, these books were printed, and Siyavula's first free open textbooks went into government schools in 2012. Because the Siyavula website URL was printed on the books' covers, the books also drove students to the website for digital versions. Google Analytics indicated a massive burst in website traffic. Mark clarified that when these books were printed "we were getting 500K unique visitors to the website per month, a huge amount. That's about 30% of the kids in that grade in the country. But the government distributed it late so a lot of the kids were reading it online, and 40% were reading it on feature phones."

The collaboration with the government was not limited to approving the completed textbooks. Government officials were involved in the face-to-face text-book sprints which Megan began to use in 2011 to author her new series of books from scratch.

From 2011 the collaborative authoring models developed further to embrace both face-to-face book-sprint workshops and virtual collaborators. For the book-sprints which ran over 3 weekends, Megan and the Siyavula team provided plenty of preparation and structure – including the development of curriculum maps showing how skills built on each other over Grades 4-6. The curriculum maps turned out to be a significant resource that engaged the development and authoring community in constructive conversations and negotiations about science pedagogy. When combined with the online authoring environment, particularly the annotation and commenting tools, they served to break down barriers between collaborators of differing rank or status – collaboration was more free flowing between classroom teachers, curriculum expert or government officials.
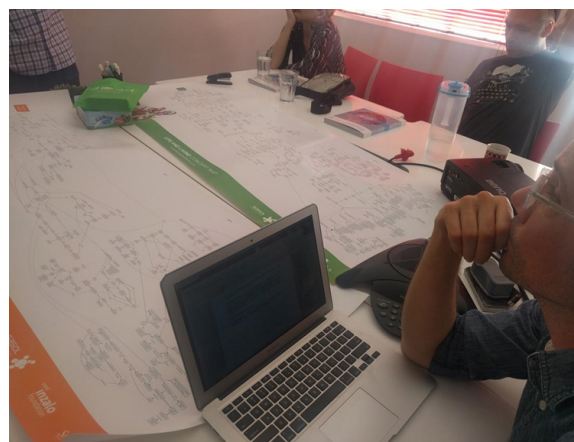

Figure 2. Curriculum maps showing learning outcomes across the years became important planning tools and also social resources that fuelled the collaborative textbook authoring process (CC-BY Sarah Lambert)

The collaborative authoring process developed over time to be a blended face-to-face and online process. Megan recalls that "initially we tried to author everything within these physical workshops, but realised the real value came from the brain storming discussions…and their ideas and practical experience of what works in the classroom, so we focussed the physical workshop on discussing this in depth and collecting all these ideas.

The collaborative authoring process developed over time to be a blended face-to-face and online process. Megan recalls that "initially we tried to author everything within these physical workshops, but realised the real value came from the brain storming discussions…and their ideas and practical experience of what works in the classroom, so we focussed the physical workshop on discussing this in depth and collecting all these ideas.

Siyavula decided to hire professional authors to write the books based on the workshop notes with input from other teachers and experts online. Later they hired a community co-ordinator who would assign online tasks such as proof-reading or translating to keep things moving along. See Figure 3 for a diagram of the new collaborative authoring model. The model helped transition a core group in a physical environment to a functioning virtual group authoring text-books.

Mark notes that having a couple of paid people doing key tasks of writing and co-ordinating actually makes volunteers feel more confident to donate their time on the project, as they are sure that there will be a useful outcome. And "so it becomes easier to recruit volunteer expertise in content authoring."
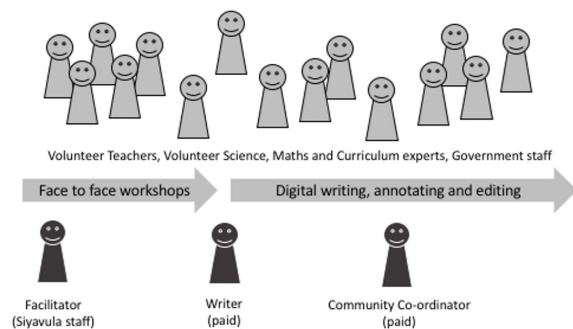
Figure 3. Siyavula's modified 'book-sprint' collaborative textbook authoring process (CC-BY Sarah Lambert)

The collaborative authoring process was also shaped to bring in a diverse range of volunteers from around the country, for the purpose of shaping the most inclusive and relevant book for both city and regional South African learners.

As Megan notes, "for the Joburg workshops, we flew up some teachers from different provinces, even one teacher from a township school in Gugulethu. Although it is not possible to make one book that will satisfy all the needs of all teachers and learners in a country, especially one as diverse as South Africa, if we have multiple, diverse voices taking part, we can strive to make content that is inclusive and representative of our country." Siyavula's intent to include diverse author's views and local context can be considered both recognitive and representational social justice actions (Lambert, 2018b).

2012: first free textbooks printed and distributed, saving the government millions

By the time Siyavula had its first free open textbooks into government schools in 2012, the magnitude of cost savings for the government became quantifiable, and real.

The Siyavula Grade 10 texts were printed and distributed. While government records are not totally clear, it seems that around 10 million books were printed and distributed to schools nationally (Goodier, 2017). A comparable text from a commercial publisher would be 250 Rand per unit printed and distributed but a Siyavula text would cost approximately 36 Rand per unit. Based on these figures then, Siyavula's model produced a run of textbooks at only 14.4% of the commercial costs which translates to 107 Million Rand in savings per text-book title with a print-run of 500K units. At the exchange rate at time of writing, this is 10.3Million AUD and 7.4Million USD.

Having succeeded to get Grade 10 ie High School maths and science texts printed and distributed to schools, Si-

yavula next authored the Grade 11 books to the new curriculum standard and expanded their publishing formats for access via mobile devices which are more commonly used that laptops in South Africa.

2011-2 showed that the maturing collaborative authoring systems were agile enough to facilitate major book modifications after curriculum change. Developing free OER texts aligned to curriculum relevant to and needed by disadvantaged learners is another success factor shared by Siyavula and other OER developers such as the Open University UK (Law, 2015).

Megan Beckett also embarked on a major project to develop Science textbooks for the primary school – Grades 4-6 Natural Sciences and Technology curriculum. As Megan notes, "We were approached by the DBE, along with a partnership from the Sasol Inzalo Foundation, to do this project. The Sasol Inzalo Foundation provided the funding for the development and production of the books, in print, ePub and online. And the DBE used a "Special Projects" budget to pay for the printing and distribution."

Siyavulas technical "pipeline" had matured so that they could output to numerous technical formats from the one source of textbook content, as Figure 4 shows below.
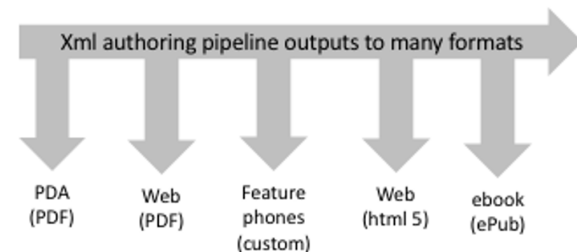

Figure 4. Siyavula's xml authoring system was a key technical resource with the ability to output to many formats (CC-BY Sarah Lambert)

2012: Siyavula becomes a company

In 2012, at the conclusion of the Shuttleworth funding, Siyavula became a company and social enterprise. Their new business model still involved cost-recovery from sponsors for textbook development, and value-added for-fee online practice services for schools and learners. These services were also sponsored so the poorer schools and learners could participate.

This was a year before David Wiley and Kim Thanos founded Lumen Learning in the US, which has some parallels to Siyavula not only in their mission to work with OER for disadvantaged learners, but also with regards to collaborating with a major funder. Lumen's early work was funded by The Gates Foundation who required them to develop a sustainable business model prior to receiving additional investment to expand their early pioneering work customising OER texts (Stacey, 2017). Where as Lumen's business model would target Higher Education institutions to pay for custom services, Siyavula looked to schools and individual learners to pay for value-added services. While both need income to sustain activity, both also put social good before profit, were seeded via philanthropic funding, and continue to provide free digital OER as a baseline service. 2013: National distribution of OER texts fills the void for 3 million learners

In 2013, Siyavula OER textbooks peaked in South Africa. The Grades 4-6 Natural Sciences and Technology work books were printed and distributed such that 100% of government schools nationally received free copies of print-

ed OER textbooks. Approximately 6 million workbooks and teachers' guides were distributed to around 3 million learners – in 2 volumes per year.

This was despite an independent curriculum review and subsequent changes to the curriculum late in the authoring process. No commercial publisher's books met the criteria for the new curriculum given the late curriculum changes. Megan and Siyavula's online authoring systems however, got the job done.

"A month of all-nighters and Megan managed to get this stuff up to speed, but the other publishers weren't able to. So these resources actually saved an entire cohort from having no educational resources for science for one of their subjects – that's about 3 million kids" notes Mark.

In 2013 Megan also led the production of the Grade 7-9 Natural Sciences workbooks, a Life Sciences Year 10 book and a Maths literacy Grade 10 book. Disappointingly, while they got approved, neither of them were printed or distributed due to shortfalls in the Minister's special projects budget.

Regardless, Google Analytics from the time indicate huge spikes in online traffic to the Siyavula website - approximately 500, 000 students were downloading the texts per month.

Learner agency and motivation was again evident in the Google Analytics massive number of downloads from those prepared to teach themselves via free online textbooks. Some were also able to use the online practice service. Many of the learners had no access to laptops or desktop computers, but nevertheless were reading texts on their low-tech feature phones.

By this time there had been continuous improvement over many years in both the quality and efficiency of Siyavulas' collaborative text-book authoring system. Book design, layout, pedagogy, and production methods had all improved.

The dedication and commitment of Siyavula staff to the work, and the commitment to improvement of systems are success factors which whilst not unique in a successful business, can be hard to achieve. Underpinning such commitment is the stability and continuity of key staff over the years and this is in contrast to the current trend for the "gig economy" or casualization of knowledge workers who are increasingly employed on short contracts with no certainly or stability. Such terms of work do not foster loyalty, commitment or going above and beyond.

2014: Post election change in textbook policy direction halts progress

In 2014, Siyavula was poised to really shake-up text-book provision for South African schools. Their production model and systems had matured and they had big plans. They hoped to produce an OER catalogue of 42 titles covering all learning areas from Grade 4 to Grade 12 for the whole country.

After the election however, the in-coming Minister for Basic Education signalled an intention for major changes to textbook policy. To save funds they proposed a central procurement of a single textbook for each grade/subject/language combination for the country. OER texts were also mentioned as a possibility. As Mark notes, this was "announced in her post-election speech. And that threw the entire publishing sector into turmoil." The government needed to change legislation for this to happen, by amending the Schools Act. However, they were unable to

do so leaving the publishing industry – both OER and commercial – in limbo for over 3 years. At the time of writing this case, the uncertainty which halted all progress or work on OER texts had still not been resolved.

Sadly for Siyavula and OER texts in South Africa, avenues to continue OER production with funders dried up. As Megan notes, "we still pursued the idea for most of 2014, trying to see what would work, but in October 2014, a high-level strategic decision was made not to continue with the OER work."

The government policy shift was a second major political event that impacted Siyavula and could not be predicted or manufactured. Unfortunately, unlike the public sector strike which enabled OER texts to solve a difficulty problem, the impact of this policy change was negative and no workarounds could be found. The stalemate meant that funders' involvement was either financially risky, or ethically and reputationally risky.

Mark notes: "All the funders we were talking to about this 42 title expansion said to us: Are we sponsoring a book that will never be used, because it's not going to be THE chosen book. Or are we sponsoring state publishing? And both of those are undesirable scenarios....So that's sort of where our OER stuff fell in a bit of a heap."

The death of promising educational technology projects due to changes to policy, funding or resourcing are relatively common or at least anticipated events post-elections events within all levels of the education sector – particularly when governments are predicted to change. However the 2014 turn of events for Siyavula seemed particularly shocking in the light of their success and incredible cost savings to government just the year before.

Regardless, the online services continued to grow and in 2014 Vodacom (major internet provider in South Africa) first zero rated their website and resources, so that no Vodacom mobile user paid data to access the services - a major boost for disadvantaged learners.

2014-2018: OER texts out of circulation, commitment to digital services

With avenues for further OER textbook production closed, Siyavula made the decision to focus on their digital, personalised or "adaptive" practice service which is now called "Siyavula Practice." Mark says: "It supplements the content in the (free online) books and enable a learner to choose topics that they'd like to practice until they've mastered them." They continue to work with supportive sponsors so that poorer schools can use the service.

Mark feels that there is potential to bring back collaborative authoring in South Africa and work with Faculty to contextualise other open books. Also, funders might be able to provide poorer, regional kids with a kindle or similar low cost e-reader with long battery time. Importantly he notes, "you don't need power at home to read it. It would take one charging station in the school, as the charge can last 2-3 weeks. So kids could charge at school and take home and read where they have no electric light, for our context."

While it became impossible to reprint and restock the earlier OER texts, older versions still circulated adding to the demand for digital versions which remain strong. Website traffic remains very high every year, particularly as Siyavula negotiated with MTN or Vodacom (the two biggest service providers) so learners can download the materials without incurring internet data charges.

Megan notes that "this has helped break down a huge barrier to accessing our OER content, as data charges are really high in South Africa, relative to other countries, and learners have very small amounts of airtime/data at their disposal, which they are less inclined to use on educational material."

Table 1. *Replicatable success factors as case study themes*

Year	Case themes, replicable success factors	
2002	Personal engagement with local community members reveals a need; Recognition of learner strengths and agency	Personal
2002-07	Motivated voluntary labour (post-graduate science students); Collaborative approach to authoring with a group of peer volunteers; Strong computing science skills within the voluntary group; Exposure to open-source software; Pragmatic valuing of 'free' over 'open' (social justice values); Awareness of lack of teaching expertise; Sought collaboration to ensure curriculum alignment.	Social Technical Personal
2007-09	Recognition of teacher risk in sharing imperfect personal teaching resources; Purchase of 'non-threatening' pre-existing publishers' texts as a basis for safe collaborative authoring with teachers; Theory of change developed – improve pedagogy and teacher capacity while creating and improving resources together.	Personal, social
2009-10	Abandon unsuccessful technical training in teacher xml textbook authoring; Recognise that it is legitimate for teachers to want to use everyday tools ie Word; Teachers invest time in learning to better use everyday tools for new purposes.	Technical, social, personal
2010	Volunteer authoring network acts as resource that 'steps up' in times of crisis	Social
2011	Leverage crisis/change to build a relationship with government; Constructive collaboration with government post- crisis; Blended text-book authoring process (face to face workshops, online editing); Curriculum maps of outcomes across year levels a key resource for teacher engagement at workshops; Hire paid authors to write up the workshop ideas; Recognitive social justice provides "diverse voices" from regional teachers of all ranks in the development of textbook resources and representational.	Social Technical, social Social Personal
2012	Maturing authoring platform for efficiency, multiple output formats and agility to late curriculum changes; Hybrid business model – free mobile friendly texts and for-fee online practice exercises with feedback; Expansion of philanthropic business sponsors to ensure poor students can use online services.	Technical Technical Social, personal
2013	Recognition of learner agency and motivation to download and learn from free digital resources; 'Zero rate' online resources so learners don't pay mobile data charges Create an environment for long-term stable, dedicated staff to stay the distance.	Personal, social Technical Personal, social

Summary of case themes

Siyavula is a unique case study of a successful educational innovation that relied on a community of stakeholders including voluntary authors, systems and expertise to manage and lead that community, and a backbone of ICT systems and expertise that allowed the books to be created in multiple digital and print formats. While the ICT or technical components were necessary, the personal or human resources and social aspects were also absolutely crucial. In particular, the Siyavula case highlights what Warschauer refers to as "Social resources" ie the community, institutional and societal structures that support access to ICT in socially inclusive ways. In fact, all of Warschauer's (2003) required components for socially inclusive uses of ICT are evident in the case themes: Technical (Physical/digital) resources, Personal resources (called "Human" by Warschauer, and here extended to include attitudinal resources), and Social resources. The values, approach or attitudinal aspects such as recognising learners' strengths and acceptance of teacher's legitimate choice regarding their role in the project are outstanding components of the "personal resources" that Mark and Megan brought to the work.

These are lessons that could be expected to have utility in other low-resourced schooling contexts. Table 1 above summarises the many replicable success factors (case themes) which were crucial to the success, longevity and sustainability of the work. These are categorised by Personal, Social and Technical – and the themes are evenly spread between the three categories. This highlights the way in which ICT "does not exist as an external variable to be injected from the outside to bring about certain results. Rather, it is woven in a complex manner into social systems and processes (Warschauer, 2003, p. 8)."

In addition to the wide ranging replicable success factors, there were also three unique and unreplicatable political events that shaped the trajectory of the project, as noted in Table 2 below. These relate to funders and government policy. In other contexts it is therefore recommended to plan to find ways to locate philanthropic funding particularly in the early phases of work, and in later phases to work constructively with Departments of Education ie governmental contexts.

Table 2. *Unique events as un-replicatable factors as case study themes*

Year	Important events contributing to project direction and eventual success
2007	Shuttleworth Foundation funded event in Cape Town leading to the Cape Town Declaration of Open Education, and the funding of what would become known as "Siyavula"
2009	Organisational restructure of the funder (Shuttleworth) making Mark Horner a Fellow, leading the project
2010	Public sector strike in South Africa, all teachers were off work for around a month leading up to the end of year exams
2014	Incoming Minister of Education policy decision on central procurement of one textbook halted all textbook development, both commercial and OER, leading to refocussing on digital services and exploring new opportunities

Discussion of Legacy and Future Possibilities

This case has shown the depth and breadth of the Siyavula legacy for South African schools and learners. Siyavula had developed: a "one book, multiple formats" collaborative authoring and online publishing system; a private-public

partnership business model with philanthropic funds and both paid and voluntary labour; a way of working with Government and internet providers so that STEM texts reached disadvantaged and under resourced learners and teachers throughout South Africa.

Siyavula had developed processes and tools that supported a new multi-stakeholder collaborative textbook production model that was neither text-book sprint (face to face) or digital community – but a blend of the best part of both models. This production model proved itself as superior to comparable commercial methods for the South African market in terms of both efficiency (cost savings) and agility (responding to late curricula changes and political moves.) It proved itself at least comparable to commercial text in terms of finished textbook output quality. They had saved the government roughly 1,200 Million Rand in textbook provision costs to public school in 2011-13.

According to recent research, "open-business models" like Siyavula's social enterprise can shift the balance of power and influence between government, the market and "the commons" (Stacey, 2017). The commons is a long-standing concept that includes publically owned natural and built resources which are shared and managed for the common public good. This includes land, air and water, footpaths and parks, and more recently the "digital commons" which includes knowledge that remains free and in public control.

In applying this concept to Siyavula and its legacy, we can see that despite significant positive outcomes, what had not changed was the balance of power and influence between government, the market and "the commons" in the South African educational resource sector. While Siyavula have certainly enriched and expanded "the commons", a problematic inequality of access to current print resources continues to compound a history of inequality, and the current reliance on old procurement systems for expensive commercial texts is still a reality in South Africa.

New digital services offer promise but are still relatively new and the outcomes on learners' success is yet to be researched. Because digital tools tend to be first adopted and therefore primarily benefit the more advantaged sections of society (Engstrom & Tinto, 2008; Selwyn, 2013) maintaining and expanding funding and supports for the newer digital services to the poorer learners, schools and communities is an area for future attention and research. In reflecting on the lack of systemic resource provision transformation, Mark calls the 2013 milestone of 100% of government schools getting printed open textbooks "a bittersweet achievement. So great that everybody has a textbook which is open, but it didn't fundamentally transform anything."

Ongoing benefit of distributed textbooks

Regardless of the print production and textbook procurement systems not shifting, the digital versions do continue to be used. The common-sense argument reasonably suggests that having access to a digital textbook is going to be an improvement on having no textbook.

Some teachers surveyed regarding the impact of Siyavula textbooks backed this up (Pitt and Beckett, 2014). Teachers noted that students were able to leave hard copy textbooks at school, and access a digital version on their smartphones at home. They were more able to make use of class-time to do their homework because they always had a digital copy of the textbook on their smart phones. Not needing to carry around heavy textbooks between home and class, and not having to worry about lost text-

books were noted many times. Another teacher noted that underperforming students' results had lifted, and another teacher who had tracked exam results over the course of a year claimed students grades had improved. Lastly, there was a long-term benefit of retaining access to previous years copies to help with their final Year 12 "matric" exams. This is important as much of the Grade 11 syllabus is examinable at the end of Matric (Pitt and Beckett, 2014). While such research provides insight into how Siyavula books - both in print and digital versions - enabled learning in classrooms and at home, the survey respondents were dominated by private school teachers who were typically is better resourced schools and areas (Pitt & Beckett, 2014). There is thus far no research looking at student outcomes across all the schooling disadvantage "quintiles." It is also not clear the extent that the textbooks help learners in their end of year exams or as preparation to succeed in higher grades. It is also not clear the extent that the digital texts (and the physical texts for the 2011-2013 cohorts) might have had an impact on international skills scores which are tracked over time. Considering the scale of Siyavula's reach for learners over multiple years, it is possible that the results may have been worse without Siyavula's efforts.

Recent research into educational disadvantage in South African has however found that long-term results in Maths and English (international testing regime ie TIMMS and PIRLS) improved slightly from 2006 but have been stagnant since, for all but the highest socio-economic status (SES) quintile. (Taylor, 2017; Taylor & Yu, 2009) The authors found that disadvantage carried forward from apartheid continues to prevent poorer and even middle-class schools from converting the significant additional resources provided to them in recent years to learning improvement. The challenges of multiple official languages and therefore of learning in non-mother tongue makes learning in South Africa's schools particularly difficult.

Megan explains the challenge of bi-lingual instruction in South Australia, "From Grades 1-3 learners learn in their mother tongue of instruction, and we have 11 official languages. Then in Grade 4, they predominantly switch to English. And now they also have to learn a whole new subject ie. Natural Sciences which starts in Grade 4 at the same time as a new language. It's no wonder kids really battle and start to fall behind at this early stage." Presumably, Grade 4 learners also have to pick up English learning formally, and transition their early maths learning into English.

This is a major challenge and not having ,any parental or community fluent English speakers suggests that the bi-lingual instruction challenge would be hardest to overcome by the poorer regional schools.

However Taylor's recent South African research indicates that even reading levels in mother-tongue language are extremely low, and much investment is first needed in family and school early mother-tongue reading initiatives as a springboard from which reading in English can more effectively be achieved (Taylor, 2017).

Taylor's research echoes Megan's observations about the extra demands of bi-lingualism and the risk of poor schooling outcomes, noting that "If children do not learn to read effectively by Grade 4, they will not cope with curriculum demands in the higher grades. Weak learning foundations, especially in reading, are arguably the main cause of dropping out of school in grades 10, 11 and 12." Taylor's research also confirms that reading well in the earlier grades is strongly predictive of reaching and passing matric, which in turn strongly predicts access and suc-

ceed in higher education. In Taylor's earlier studies, many measures of disadvantage were investigated and the lack of textbook or having to share a textbook was found to be a factor for poor English results (Taylor & Yu, 2009).

Potential for collaborative authoring systems for reading and multi-linguialism

Considering all these factors, then it seems likely that the return on investment in the development of a range of free and low-cost maths and science resources would increase if learners had better base reading skills.

There are many ways that OER authoring systems could assist improvements in mother-tongue and early English reading, if suitable funders and academic partners could be found. There seems to be a need for additional foundational reading resources - both in the 11 mother-tongue languages as well as in English - that OER collaborative textbook systems could potentially support. Taylor's research also suggests that provision of free English school texts throughout all the years would also assist learners progress to matriculate.

Considering that many South African teachers are also bi-lingual or multi-lingual, Megan notes that another strength of the OER collaborative authoring system is the ability to translate teaching guides back into mother-tongue languages, to be used as support materials for learning the subject in English. Megan notes, "This did happen in one small instance where a group translated our workbooks into isiXhosa to use in some rural schools in the Eastern Cape."

Taylor's research into the importance of parental and adult support for using English would suggest that investing in lifting adult community English and literacy levels across the board may also assist the effectiveness and efficiency of investments in school literacy. The transformational work of Freire's "learning circles" to lift adult literacy level in Brazil may be a model that is useful, as the radical method successfully engaged "peasants" or regional illiterate agricultural workers in areas of great poverty and inequality within 3-5 years (Finn, 1999; Freire, 1994; Gannon, 2017). Other recent global methods to raise community literacies involve programs to distribute free children's books to families for shared reading, and the translation of well-known traditional stories from one language into English to assist bi-lingual learners and families to learn English using known and culturally appropriate texts. OER authoring and publication systems, including cheap e-readers and free online courses might also assist with these efforts as they have done in other bi-lingual contexts, within the context of supportive facilitated local study or discussion groups (Charbonneau-Gowdy, Paula; Capredoni, Rosana; Gonzalez, Sebastian; Jayo, María José; Raby, 2015; Colas, Sloep, & Garreta-Domingo, 2016).

Indeed, a number of early reading initiatives are emerging in South Africa including "Bookdash" (https://bookdash.org/) which uses a similar collaborative book-sprint model with voluntary authors, illustrators and designers to create new African storybooks that anyone can freely print, translate and distribute. Nali'Bali (https://nalibali.org) focusses on multi-lingual early reading texts, and Fundza (http://www.fundza.co.za) creates fun, teen-friendly print and electronic books supported by reading groups, lending libraries and lifelong literacy programs.

Conclusion

This case study has shown that Siyavula developed a sustainable social enterprise business model, ahead of its time, involving a mix of philanthropic, voluntary and commercial resources. Social enterprises in the education sector show it is possible to sell educational tools not to make money, but to subsidise resources and tools for the benefit of learners including those in the under-resourced contexts.

Siyavula leave a strong legacy of the development of multi-stakeholder text-book sprints where an intense face-to-face experience provides the ground-work for a constructive virtual authoring and editing process which is inclusive of diverse stakeholder input across different roles and ranks. Such processes advance curriculum and pedagogy sharing, expertise and capacity building.

Collaborative authoring systems have significant potential not only in South Africa should policy be turned around, but also in other parts of the world. Collaborative authoring systems also have potential beyond the classroom, to support efforts to lift reading and speaking non-mother tongue languages for both adults and children.

Mark notes in conclusion, that "if you just make a text book open and slap an open textbook licence on it, I don't think you fundamentally make it better than before. What makes open great, is that it could be collaboratively authored by a community."

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