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The Bold and The Backlash: When Marginalised Voices are Heard in Neoliberal Land

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Abstract

The hierarchy in our educational institutions and services often mirror societal attitudes towards power and whose voices are privileged or ignored. Historically, those with power feel uncomfortable when marginalised voices are heard. There is a lot at stake when power is threatened and new voices demand changes within society. This discussion paper explores various instances of where that has happened and the backlash faced by those who are given a chance for their opinions to be heard or those who assist them to voice their narrative through research and reporting. Using publicly available data and our own experiences, we examine incidences where society has listened to children, the victims of sexual abuse in institutions and Indigenous Australians. For people to reach their potential, their voices need to be heard in matters that affect them, according to the United Nations Human Rights Declaration (United Nations, 1948). Using discourse and narrative analysis, the authors discuss the cost of exercising those rights within a neoliberal context and examine how this influences peoples' agency as they face media backlash, online trolling and death threats. Despite this, when marginalised people are bold enough and are allowed to tell their stories, societies, educational institutions, and services have the chance to adapt and improve. This will interest those who educate and research with marginalised people or who study social and institutionalised power.

Keywords:

Neoliberalism, Agency, Indigenous Voice, Children's Agency, Sexual Abuse, Human Rights, Climate Change Activism

Introduction

Educational institutions often mirror the power structures found in society, with favour and opportunities to be heard available to those who hold power. Those with power in society can maintain power only if they can control those with less power. Control can be exerted physically, economically, socially, culturally, emotionally, verbally, and in other ways. This paper explores social, verbal and economic methods of control through silencing of voices of those who are marginalised. If marginalised groups do speak out, or others speak for them, there is a consequence for breaking that silence. Despite United Nations writing the Human Rights Framework in 1948 (United Nations, 2020), this

paper argues that such ideals cannot be fully realised within a highly controlled neoliberal context such as exists in Australia and many other Western nations. To examine this issue, we first outline the neoliberal context, the Human Rights Framework (United Nations, 2020), the silencing methods, and then explore three groups of marginalised people. We examine instances where children, victims of childhood sexual abuse, and Indigenous communities have been bold enough to speak out or had others speak out for them and the backlash this speaking out has caused. We explore the ramifications for those who teach, research and work with marginalised groups and how we might move forward as a society.

Neoliberal context

The economic context in which most Western countries operate is neoliberal, which frowns upon state responsibility, intervention and safeguards within the economy (Monbiot, 2017). Neoliberalism rose to prominence after the Great Depression, when the previous economic model, Cambrianism, appeared to be failing (Monbiot, 2019). Neoliberalism relies upon the privatisation of services, deregulation of markets, free-market capitalism and the rise in power of the economy to drive society forward through consumerism and the idolised entrepreneur (Chomsky, 1999; Chomsky, 2016; Monbiot, 2019). Neoliberalism encourages consumerism and competition, seeing these as the drivers of progress within society, ignoring human tendency for altruism and the way societies can improve outcomes by working together (Monbiot, 2019; Chomsky, 1999). The ideal neoliberal citizen is willing to conform to standardised expectations, aiming to earn a sufficient income through this conformity to consume and be independent of others (Azevedo and Jost, 2019).

Birch (2015: 576) claims "neoliberalism is a hegemonic ideology tied to the restoration of class power ... [a] social order in which the capitalist class allied with the managerial class to restore elite incomes through financialisation and the disciplining of workers." Under the neoliberal framework, managerialism and control flourishes, and managers become highly prized and rewarded with inflated salaries (Rogers, et al., 2020; Sims, 2020). Managerialism is justified by the belief that standardisation and compliance are essential for an organisation to stay competitive and to control the quality of the end product or service (Rogers, 2021; Rogers, Dovigo & Doan, 2020).

Despite the economic nature of neoliberalism doctrine, it has been applied quite clumsily to other areas of our lives, such as healthcare, social work and education (Macías, 2015; Moloney et al., 2019). Indeed, it is still unfolding in our lives, creeping in to control the role of academics and journalists as they critique the actions of the powerful within society (Doran, 2019; Sims, 2020). Thus, neoliberalism "may be seen as a ubiquitous, totalising, and epoch-defining phenomenon" (Bettache and Chiu, 2019: 9), and even "the new common sense" (Carlen, 2018: 25). It has become so ubiquitous that some perceive it as a theory of everything (Rowlands and Rawolle, 2013).

Under the neoliberal model, the powerful have much to lose if members of society without power start to question and undermine their authority, the status quo and the very model that has made them flourish (Graeber, 2019). As an economic model, neoliberalism creates a vast divide between the rich and the poor and then blames the poor and marginalised for their inadequacies (Monbiot, 2019). Oppressed people are positioned by neoliberal thought as the authors of their misfortunes; structural inequities are not recognised, so that lack of success is solely attributed to individual failure (Hartwich and Becker, 2019). Given this positioning as failures, the voices of people who are thus marginalised are not valued, and the messages they wish to communicate are not given credibility. Only the powerful convey messages that are worth hearing. In our neoliberal world, the messages of importance come from those with status, and it is these messages that have the power to shape our world. Silencing of marginalised voices is thus a key feature of neoliberal ideology, and the rights of those who are marginalised to be heard are overlooked. This paper explores what happens when these marginalised voices are heard and why they need to be heard as people exercise their human rights.

Human Rights Framework

Historically, there have been many instances where people lacked the power to be heard in Western countries. In feudal times, for example, the general population did not have the right to be heard. Those with wealth, power and education used many methods to quieten those who spoke out or questioned authority. During various times since then, the amount of freedom the general population have has seen many reforms. Freedom of speech has also fluctuated depending on who was in power. However, the Universal Declaration for Human Rights was proclaimed in Paris in 1948, soon after the end of World War II. The Declaration was considered a milestone in human rights' history for achievements to be obtained for all people across the world (United Nations, 2020). The declaration is comprised of 30 Articles, and two articles relevant to the framing of this paper are Article 19 and Article 29.1:

> *Article 19. Everyone has the right to freedom of opinion and expression; this right includes freedom to hold opinions without interference and to seek, receive and impart information and ideas through any media and regardless of frontiers.*

> *Article 29 1. Everyone has duties to the community in which alone the free and full development of his personality is possible. (duties may include speaking up when there is injustice or a need for action).*

The nine vignettes presented in this paper include people who have asserted their rights that align with these two Articles. All people are deemed by the UN Human Rights Declaration to have the right to speak their opinion without interference. But how are they heard and listened to? How does the general population respond, and in what way do people in power and the media respond? For people who speak up when injustice has been perceived, how are they heard? And what is the response to their voices? The following nine vignettes present the voices of people who have spoken up, expressed their opinion, and experienced backlash. Is backlash a violation of rights, and does the acceptance of this backlash signify a cultural shift towards totalitarianism?

This issue is highlighted on occasions when a person expresses their opinion and is consequently vilified by others. This vilification could be perceived as a breach of Articles 5 and 12 of the UN Declaration for Human Rights:

> *Article 5.*
> *No one shall be subjected to torture or to cruel, inhuman or degrading treatment or punishment.*

> *Article 12.*
> *No one shall be subjected to arbitrary interference with his privacy, family, home or correspondence, nor to attacks upon his honour and reputation. Everyone has the right to the protection of the law against such interference or attacks.*

This paper argues that the vilification currently evident in academia and the public domain represents a shift in the common understanding of the Declaration for Human Rights (United Nations, 1948). This shift, we argue, increasingly creates a context where 'right' and 'proper' messages are considered socially acceptable, but those deviating from what is 'right' and 'proper' are viewed as needing to be stifled, and those voicing these messages need to be corrected, or addressed, to maintain the status quo. In our increasingly neoliberal world (Sims, 2020, p. 71), argues "Ever growing compliance demands and ever-decreasing agency associated with the growing punitive audit culture" works to silence voices and ensure that only the standardised, acceptable messages are heard. While the authors of the Declaration of Human Rights (United Nations, 2020) wrote the articles as ideals, we argue that these cannot be achieved under a neoliberal framework. It is important for countries to check that these rights are fully realised (Jackson & Allan, 2010). To assist with this, we will first present nine vignettes to illustrate the operation of this silencing then proceed to synthesise our argument in the discussion. The vignettes use two different styles, one that ties together various media quotes for the voices of children and victims of child sexual abuse and a narrative style for the Indigenous voices due to the different anecdotal data.

Silencing

Not being heard and/or responded to respectfully when someone speaks up about an issue that affects them has been recognised as 'silencing'. Emerick (2019) argues that silencing prevents someone from communicating and is viewed as a violation of integrity, and can challenge people's beliefs. When people with power respond to those recognised as not having power, such as children, it is a response that could be interpreted as viewing children as 'not-yet citizens' (Canosa, 2016). Such actions are socially unjust and represent the notion that speaking up is an unpopular action that is frequently followed by reprisals (Wiggan, 2019).

Voices from the margins can inform public opinion in such cases and bring issues that have been long suppressed to the fore (Wiggan, 2019). Speaking out for social justice is viewed as being in the common interest advocating for the common good (Griffiths, 1998 in Bradley, 2007). In 2017 there were raids in the Australian Broadcasting Commission (ABC) journal offices and two other media offices by the Australian Federal Police (ABC, 2019). The media groups united to demand justice for the journalists as the ABC Managing Director explained: "No-one deserves to be punished for doing their job and pursuing information that is clearly in the public interest" (p. 1). This incident has raised debate about who then decides what is for the common good? Usually, such decisions are made by those in power, and those in power make decisions that significantly influence people's lives (Bradley, 2007). However, the following nine vignettes bring questions to this view.

Conceptual Framing

The conceptual framing of this paper is illustrated in Figure 1. We argue that the neoliberal context in which we live creates an expectation of conformity to which those in marginalised groups do not meet. As a consequence, the voices of people who are marginalised are not respected and are often silenced. Where they are heard, the messages they share are not attributed any importance. Children are one such group considered as marginalised. Millei and Kaffei (2018) identify that children learn about right and wrong and how to act in challenging situations as a result of how those around them respond. Thus, when marginalised voices speak out, the neoliberal reaction is either to shame the speaker, the message or both. Speaking out requires acts of courage which may sometimes be rewarded when words are heard, and community understandings may change as a consequence. More often, such acts of courage are

not rewarded, and the speakers are reviled, made fun of, or generally disregarded. We argue that speaking out is important because of the potential to change community attitudes and values. Along with the potential to change the way we see and act in the world, listening to marginalised voices honours the Declaration on Human Rights (United Nations, 1948). All voices have the right to be heard. Neoliberal silencing is a form of behaviour that does not respect this declaration. In the following section of this paper, we share examples of silencing and speaking out that illustrate the operation of our conceptual framework.

Methodology

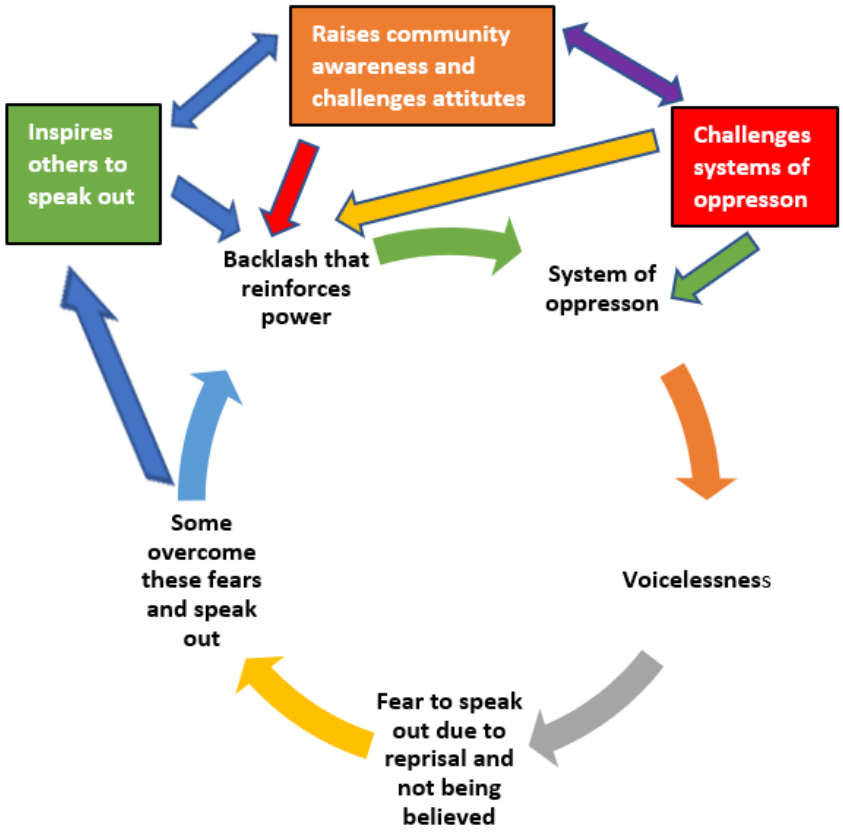
The first two topics explored in this paper, children's voices and the voices of victims of child sexual abuse, came together through the authors' discussions about similar themes they represented. The third theme, about the voices of Indigenous Australians, emerged from the discussions about how these themes had impacted one author's work. As we reflected on substantial similarities, the authors decided to delve further into the topics using a combination of discourse analysis (for the first theme about children's voices) and narrative analysis for the second two themes. Discourse analysis is often used to 'answer questions about social relations, such as dominance and oppression' (Johnstone, 2018, p. 6). Narrative research explores the stories of people (Polkinghorne, 2007), focussing on the meaning behind the stories. The meaning created by narrative brings together humans' experiences and behaviours (Polkinghorne, 1986) and how they relate to each other and other living things. These themes were then analysed within the neoliberal context of Australian society and the Declaration of Human Rights (1948) to provide a better understanding that would enhance the overarching theme of the paper. This has been summarised in Figure 2.

The paper relies on publicly available data and narrative reflections, so it does not require ethics approval. However, the authors must act ethically. To do that, they have not revealed the identity of any characters in the narrative reflections, other than the author themselves.

The voices of children

The world has witnessed marginalised groups being heard, and what has been the response? Greta Thunberg, when she was 15 years old, appeared on television/social media striking from going to school, outside the Houses of parliament in Sweden, protesting for action to be taken on climate change. Her message was clear: world leaders need to take action on climate change to protect the Earth. As a result of her actions, students from around the world began to take action, and to join Greta in her campaign to bring

Figure 1
Conceptual framework



about change. The western world witnessed mass strikes by school students under the banner of Fridays for the Future: FFF. Greta explained to British MPs that the lack of action on climate change was 'ongoing irresponsible behaviour' and 'the greatest failure of humankind' (Australian Broadcasting Commission [ABC] News, 2019, August, 2). The vignettes for this section can be found in Vignettes 1-3 in the appendix.

How did the world leaders of countries respond to Greta Thunberg? Vignette 2 illustrates Greta's influence and the insulting comments made by world leaders on her actions. These comments were made by powerful men who criticised Greta for being angry, stating she was mentally disturbed and she should be in school learning. Claims were made that she was creating needless anxiety, and she should not be politicising and advocating for the environment. Such comments go against the intentions contained in Articles 5 and 12 of the UN Declaration on Human Rights; that there not be degrading comments made, nor should there be attacks on a person's honour or reputation. Yet it seems that these world leaders were angered by her actions and thought it acceptable to publicly act counter to her human rights. While Greta has been criticised, others have turned her into a hero, yet also a villain, as she challenges the rights of countries to forgo action on climate change to support their economic growth. An analysis of Greta's actions, which was arousing worldwide action on climate change by students, were identified by Barry (Media Watch, 2019) as making a difference which was why leaders were angered. Greta has held firm to linking her actions to climate science despite ongoing criticisms of her actions. She continues to assert that action is needed to be taken now to preserve the world for the future.

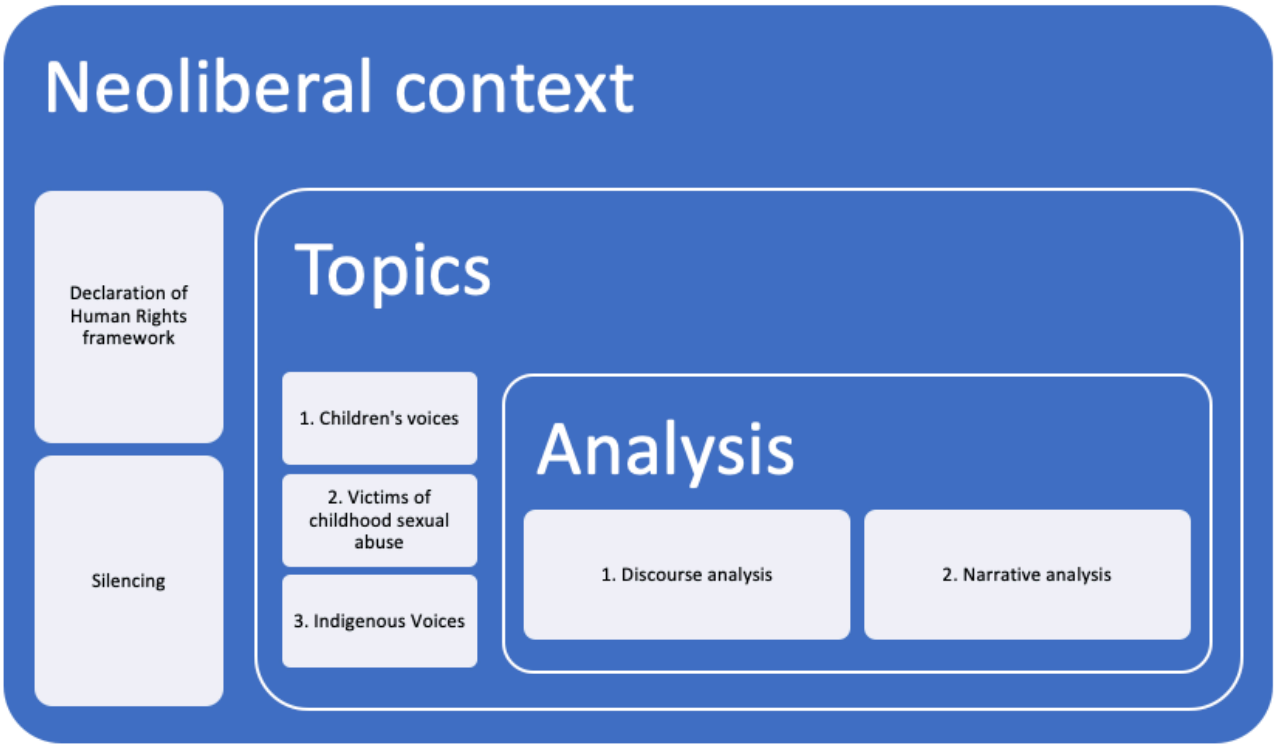
Vignette 3 highlights the dismissal of children's voices by the media and politicians- people with power. When four-year-old preschool children expressed the view that the Aboriginal Flag should fly on the Sydney Harbour Bridge along with the Australian flag, they were met with belittling comments: they were not old enough to express such ideas, and that they have been manipulated and 'politicised' by their teachers. Such comments attack children's rights to speak out, and the children's reputation was not honoured (Article 12). Children in this Vignette were portrayed as being incapable and incompetent when it comes to speaking out on such an issue. Yet the Early Years Learning Framework (Department of Education, Employment and Workplace Relations [DEEWR], 2009), mandated for use in early childhood settings throughout Australia, recognises children as capable and competent:

> *They (children) recognise their agency, capacity to initiate and lead learning, and their rights to participate in decisions that affect them, including their learning (p.10).*

with Learning Outcome 2.1 starting that early childhood educators should support:

> *Children develop a sense of belonging to groups and communities and an understanding of the reciprocal rights and responsibilities necessary for active community participation (p.29).*

Figure 2
Context, framework, topics and analysis



The Education Minister was cited as saying that children should not be engaging in such acts but should be playing (Daily Mail, 2019, October 23). Yes, children do learn most effectively through play, and they also learn that they can actively participate in supporting the rights of people. But children need to be heard, as Craig Reucassel (2020) highlighted when watching a climate change protest:

> *"...it doesn't feel like we are doing enough to see them get out here- they feel useless...and they're going to be the ones dealing with this. It's going to be the kids."*

The voices of adults who were sexually abused as children in Australian institutions

Another marginalised group in Australia whose voices are often silenced are those who have allegedly suffered sexual abuse as children within our institutions. Vignettes 4-6 in the appendix provide examples of the media coverage of this issue.

Children are arguably one of the most powerless groups in our society. One of the problems with institutions is that they render children particularly vulnerable (Munro and Fish, 2015), and vulnerability is one of the areas studied in victimology. Burgess, Regehr & Roberts (2011) explain that victimology is the study of the victim, the offender and how this sits within society. Some of the major theories and critiques of victimology are listed in Table 1, along with the way 'Bernie' as an alleged victim within the vignettes aligns within these theories and ideas both as a child and adult. One of the challenges for victims of child sexual abuse, as shown in Vignette 4, is the difficulty of reporting. Fears that they would not be believed against the word of a more powerful adult are common. In Vignette 5, the accused is also someone who carries the authority of his position within the church and the broader community in which he lived. Thus he is able to use the 'cultural and community factors', including power positions (Burgess et. al., 2011). This is exacerbated because victims are reporting something personal and related to their body and sexual acts, so they feel a sense of embarrassment and guilt, that they may have somehow done something wrong, rather than been the victim of abuse from a more powerful person. Other barriers to speaking up are in our legal institutions that have been established to deal with adults giving evidence about recent events rather than historical events they experienced as a child. The nature of sexual abuse means that some of the episodes might have occurred in private, so witnesses may not be available. Acknowledging this, it is now recommended that children and other vulnerable witnesses should be assisted by the use of video interviews conducted by someone with suitable training (Commonwealth of Australia, 2020). This alone does not deal with the many barriers for victims to speak up, as shown in Table 1.

Despite this, there has been an increase of complaints against abusers in many of our institutions, including state, Catholic and independent schools, foster care homes, orphanages, extra-curricular organisations, cultural organisations and faith groups. It is important to note that Vignettes 4-6 represent one church in the interests of brevity. However, there are multiple examples from most faith groups, as indicated in the Report from the Royal Commission into the Institutional Responses to Child Sexual Abuse (Commonwealth of Australia, 2020). This paper is not commenting on the guilt or innocence of the accused, but rather the role of power and the difficulty facing children to speak up when they are abused or at a later time in their life when they are re-victimised. Dr Viv Waller talks about the courage these victims needed to report these issues to the authorities. It is important to note that historically, victims sometimes reported the abuse to their parents, only to have the church leaders brush the matter aside, silence them, or organise for the abuser to be moved on to another parish or country. Such abuse of power serves to further squash complaints, as victims see the pain of reporting as futile, recognised in Dr Waller's comments and even Cardinal Pell's in Vignette 6. Archbishop Coleridge gives a very graphic picture of the institution's power when he comments on its 'dark and destructive' nature (Fulton, 2020). The unravelling of the extent of the abuse and the cover-ups within the church have left some church leaders, and parishioners surprised and left to deal with the loss of trust, as shown in Father Eric Bryant's comments.

When victims do report, they also face the possible backlash through social and traditional media, the institution and members of the community. This prevents victims from coming forward, or when they do, they ask to remain anonymous, such as the case of Witness J, who didn't want the case to define him and wanted to protect his family. Those who try to give the victims agency, such as the police or some sections of the media, are accused of incompetence, witch hunting and using vulnerable people, as shown in the comments of Andrew Bolt and Cardinal Pell in Vignette 6. Indeed, the institution's leader, Pope Francis labelled those who accuse the church as being connected with the Devil. Burgess et. al. (2011) describe this as victim-blaming, where victims' actions are seen as directly causing someone to commit criminal acts or are blaming others for something they have done. Conversely, Munro and Fish (2015: 37) state that 'A shared acknowledgement of how difficult it can be to detect and respond effectively to abuse contributes to a culture that keeps the issue high on the agenda'. The Royal Commission has published several recommendations for particular institutions to ensure abuse is prevented and victims' voices are heard. This positive step also needs to be mirrored in our legal institutions so that the process is less harrowing for victims. Perhaps there also needs to

Table 1

Theories and ideas of victimisation and victimology

Theories and ideas of victimisation and victimology	Bernie as an alleged child victim of sexual abuse	Bernie as an adult victim of silencing (structural revictimisation)
Victim precipitation (passively behaviours that may make crime easier)	Being compliant within the institution's rules Recognising power structures Wanting adult attention because he was an orphan	Being compliant within societies rules Avoiding revictimisation by not testifying in court Recognising power structures No family support Mental health issues
Lifestyles (situational factors that make crime more likely)	Orphan in an institution	No family support
Routine activities (activities/situations Bernie was involved in that made him more vulnerable)	In an institution with motivated offenders Lack of a capable guardian (orphan and his guardian became the alleged offender) Bernie was a suitable target (he was compliant and respectful to adults in the institution)	Some media and church leaders (motivated silencers) Lack of capable guardian (police and justice system unable to make the system 'safe' for Bernie to speak out) Bernie was a suitable target (thinking he would not be believed as an orphan, nor an ideal victim [Christie, 1986] because he knew the offender)
Victim proneness	Young, minority (orphan), lonesome (von Hentig, 1948)	Blocked, lonesome, broken hearted (von Hentig, 1948)
Opponents of positivist theories	Poverty and vulnerability in institutional care, victim-offender relationship (Bernie trusted and admired the alleged offender, ignorant to grooming behaviour, sexually innocent [Brookman, 2005])	Victim blaming (some media and through revictimisation in the justice system [Amir, 1971])
Critical victimology	Structural (Bernie's poverty placed him at higher risk [Mawby & Walklate, 1994])	State power (have the power to apply or deny the label of 'victim' through the court system)
Denial of victim status	Powerless more likely to be victims but less likely to be given victim status (Bernie didn't think he would be believed)	Hierarchy of victim status (Bernie believing he would not be believed because he was from an orphanage)

be some guidelines and training for journalists around victimology and re-victimisation for victims and alleged victims of child sexual abuse.

The voices of Indigenous Australians and the powerless

Another marginalised group in Australia whose voices are often silenced are our Indigenous community, as demonstrated in Vignettes 7 to 9 in the appendix.

Vignettes 7, 8 and 9 provide examples of silencing of Aboriginal and Torres Strait Islander points of view. This silencing began with the first white settlement of Australia when Indigenous people were positioned as not quite human: "Human evolutionary ideas ... had the Aboriginal closer to an ape than an Englishman" (Crawford, 1989: 14). This positioning justified extreme silencing: "killing was regarded as a justifiable preventative measure" (Rowley, 1970: 72) where not only voices were silenced, but where an entire race was targeted for extermination. Later in Australian history, silencing occurred through enforced assimilation: attempts to change Indigenous people, so they more closely matched the white norm.

> *The objectives of White Australia were assimilationist, creating an ethnically homogeneous society. The Aboriginal population was expected to die out, with those of 'mixed race' (now the majority) assimilating into the majority population to the point of eventual invisibility (Jupp, 1995: 208)*

In more recent times, silencing continues, with Indigenous voices silenced through overly punitive actions when those voices speak something contrary to the norm. In the case of our work on the Indigenous child care plan, the work was embargoed, and the team was subject to legal sanctions were they to share any of the ideas collected from Indigenous participants. Vignette 8 shows that the voices of Indigenous families are still silenced, even when those voices speak for their most vulnerable members, their children. Vignette 9 is a timely reminder, particularly given the recent George Floyd riots and the Black Lives Matter protests worldwide (Bing News, 2020), that racism continues to exist throughout our societal

structures, including our justice system. The voices of Indigenous people subject to this inequitable treatment may be heard in riots and protests but continue to appear to make little impact on the systems that oppress them.

Discussion

As identified in our Conceptual Framework, there are multiple examples of the way in which the voices of those who are marginalised are silenced in our neoliberal context and examples of how those who do speak out are attacked and denigrated. The attacks may focus on the speaker, as in the case of Greta Thunberg. For example, leaders around the world spoke out against Greta Thunberg, including the Australian Prime Minister Scott Morrison, Donald Trump, the President of the USA and media sources including Andrew Bolt. Attacking the speaker creates a climate of fear. For example, one of the victims of child sexual abuse was quoted as saying: "Who's gonna believe a little boy from a home against that conglomerate mate, you know, against that bloody Goliath? [Alleged victim of child sexual abuse 'Bernie' (Fulton, 2020, 26.37)]. The Australian Royal Commission into Institutional Responses to Child Sexual Abuse showed the role our institutions, including educational institutions, have played in silencing children's voices.

Alternatively, attacks may focus on the message, attempting to falsify the message or simply ignore what is being said. The example of Aboriginal and Torres Strait Islander deaths in custody is an example of this. Despite official government findings of inequities, the situation has not improved, rather it has gotten worse. One might argue the same in terms of the recent deaths of black men in police custody in the USA; such inequities were well known, and nothing changed until a flashpoint was reached. The recent death of George Floyd triggered international Black Lives Matter riots. Whether such awareness will actually make a difference is yet to be seen. The climate change debate provides multiple examples of 'experts' claiming that the climate change evidence is false. For example, 56% of Republicans in the USA Congress claim that the climate change evidence is false, some even claiming that the evidence is a hoax (Gregoire, 2015). Digital media plays a role in creating networked communities that share climate change information and misinformation and create a spurious sense of legitimacy (Bloomfield and Tillery, 2019).

It is normal human behaviour to seek information that supports one's own position, a trait labelled as confirmation bias by Ball (2017), and the internet makes it possible for people to easily create networks of like-minded people. This human characteristic makes it even more likely that voices speaking something different are not heard, even to the extent of following the majority. Ball, for example, cites research demonstrating that "59% of people would confirm the popular answer" even when that went against their own experience (Ball, 2017: 188). Kaiser (2019) argues that it is exceptionally difficult to change people's opinions when these opinions are supported by others in their group and when the opinions fit with their own values. For example, in a Swedish study, Jylhä et al. (2019) found that negative attitudes toward feminism and women coupled with right-wing socioeconomic attitudes were linked to climate change denial, suggesting that there are groups of values that feed into each other to create a particular mindset. This suggests that minority voices speaking messages that run counter to hegemonic, neoliberal ideological positions are facing difficulty to be heard and to have an impact. Not only are they speaking against the 'norm', they have to counter the human propensity to fit in with the majority, to be perceived as part of the group.

As a consequence, we argue that whilst the UN Declaration of Human Rights is a crucially important document, there are elements in our current culture that act against its implementation. The ability of humans to challenge their own values and thinking is dependent on education (see Seligson et al, 2019 for example). Unfortunately, in our neoliberal world, it appears that schools are not perceived as a tool for values education. For example, the history of inequitable school attendance and performance for Indigenous peoples demonstrates that schools are not providing equal opportunities for minority Indigenous voices to learn the skills needed for their voices to be heard. In Vignette 3, it is reported the NSW Education Minister Sarah Mitchell said it was "deeply concerning to see three-year-olds politicised, regardless of the issue." "Children this age should be engaging in play-based learning, not being co-opted into political games by the Opposition" (Daily Mail, 2019). Australian Prime Minister Scott Morrison was reported as saying: "Each day I send my kids to school and I know other members' kids should also go to school but we do not support our schools being turned into parliaments," and "What we want is more learning in schools and less activism in schools" (BBC, 2019). In a world where hegemonic neoliberal principles strongly influence a large percent of our population, where people are more likely to follow the group rather than take a lone stand, the opportunities for silenced voices to be heard and to make an impact are very few, despite evidence of acts of courage from some. Until the neoliberal ideal of standardisation and conformity are challenged, this is not likely to change. However, as educators, researchers and educational workers, we need to reflect deeply on the structures in our workplaces and in our own practices.

Need for further research

This paper highlights the systemic power within our neoliberal society and how those with power position those without power through dampening, silencing or belittling their voice, effectively ignoring their human rights. While there are studies about neoliberalism, human rights, power, silencing and marginalised voices, this study has provided a platform to bring these some challenging issues together to discuss some of the difficulties marginalised groups face within Australian society. Further multidisciplinary research and discussion about the rights and the barriers to achieving those rights are evident for children, victims of child sexual abuse and Indigenous people within our society to increase awareness and offer a way to address these issues.

Conclusion

This paper has explored examples of the power of people within the neoliberal context when marginalised groups speak out against practices that are viewed as infringing human rights. The responses by those in power suggest that they are threatened by these actions and then aim to silence those who speak out by belittling them and suggesting disbelief of the marginalised persons' actions. However, it is clear that the actions of those who have spoken out are bringing about change: for example, Greta Thunberg has mobilised millions of school children to demonstrate against lack of action on climate change, which has raised awareness throughout the world of this issue. If our societies are to be 'free' then in the words of Crossman (in Fitzhenry, 1986) 'The main task of a free society is to civilise the struggle for power' (R H S Crossman in Fitzhenry, 1986: 239).

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Appendix

Vignette 1

"In August, (2018) when she was still 15, Ms Thunberg protested outside the Swedish Parliament with a sign reading "school strike for climate". It quickly inspired a global movement, with thousands of Australian students striking to demand climate change action in November (2018) and again in March (2019).

"Over the past year, Ms Thunberg has taken her message, calling out what she sees as a lack of necessary action on climate change, to the World Economic Forum in Davos; the EU Parliament in Strasbourg; and the National Assembly in Paris.

"This ongoing irresponsible behaviour will no doubt be remembered in history as one of the greatest failures of humankind," she told British MPs in April (BBC, 2019, April 23).

She agreed that she was too young to be doing all this, but that she felt she had to. "If everyone listened to the scientists and the facts that I constantly refer to, then no one would have to listen to me or any of the other hundreds of thousands of school children on strike for the climate across the world," she wrote. (Australian Broadcasting Commission [ABC] News, 2019, August 2).

Vignette 2

Those people in power, such as the President of the USA, Australian Prime Minister, reporters on national television, and those making money out of coal mining, that has been linked to climate change, hit back calling Greta 'deeply disturbed', that she 'should work on her anger management', and that she should 'chill', go and see a movie and go to school. Some described her as a hero (and a villain), while others viewed Greta as brainwashed as the following quotes highlight:

"Swedish climate change activist Greta Thunberg has hit back after being called the 'deeply disturbed messiah of the global warming movement' in an Australian newspaper column. The 16-year-old says what disturbs her is children being attacked for acting on the science of climate change. I have never seen a girl so young and with so many mental disorders treated by so many adults as a guru," Andrew Bolt (ABC News, 2019, August 2)

"Greta must work on her Anger Management problem, then go to a good old-fashioned movie with a friend! Chill Greta, Chill!" Mr Trump wrote on Twitter (The Guardian, 2019a)

"You say children shouldn't worry ... don't be so pessimistic and then, nothing, silence," Ms Thunberg said.

"It was shocking see our prime minister condemning students as young as eight, who are sacrificing a day of schooling to stand up for a safe climate future," Sykes told AAP. "When young people try to have a voice in politics, Scott Morrison is shutting them down, yet he's happy to listen to the coal lobby and big corporations who continue to profit from making climate change worse."

"Each day I send my kids to school and I know other members' kids should also go to school but we do not support our schools being turned into parliaments," Morrison told parliament on Monday. "What we want is more learning in schools and less activism in schools." Scott Morrison has responded to an impassioned speech by the Swedish teenage climate activist Greta Thunberg at the United Nations by declaring the climate change debate is subjecting Australian children to "needless anxiety". (The Guardian, 2019b)

"Greta has galvanised the world's attention on the most important problem in human history in a way that no one has ever done before," says Holtaus. "She has become both a hero and a villain, depending on your willingness to accept the blunt truths she tells. Her critics say her approach is too confrontational, too divisive." (Irish Times, 2019)

An analysis of how the media and those in power have responded to Greta was presented by Media Watch host, Paul Barry. Barry cited various verbal media presentations including those above and one from Fox News in the US that stated: "The adult who brainwashed these kids should be brought up on charges of child abuse". Barry then addressed the responses to Greta's address to the UN by asking "Why does she get them so angry? Is it because the adults are finally taking notice? The world is listening to a 16-year-old girl for the first time in history. You (pointing at the audience) have more brains compared to some in the media" (Media Watch, 2019).

Vignette 3

Educators at a community preschool have facilitated children as young as three to solicit signatures and lobby the government to fly the Aboriginal flag permanently on the Harbour Bridge. But a child psychologist has warned the children have no idea of the issues at stake and are merely being used as pawns to achieve the political objectives of adults.

"These children do not even have the cognitive ability to understand what a petition is," child psychologist Dr Michael Carr-Gregg said. "I think the idea of roping children into political campaigns seems to be in vogue. Children should not be used as props."

The spokesman dismissed scepticism about the children's understanding of the issues and said that as educators "we listen to the children and ask them how they want to help." That argument has been dismissed by educators who said the children under five would not know how to spell "advocate" let alone know what it means or comprehend 10,000 as a number. "It's ridiculous, they are being manipulated," said one primary school teacher.

NSW Education Minister Sarah Mitchell said it was "deeply concerning to see three-year-olds politicised, regardless of the issue...Children this age should be engaging in play-based learning, not being co-opted into political games by the Opposition."

Aboriginal leader and politician Warren Mundine said the issue was not about the Aboriginal flag but what children were being taught. "I always love seeing the Aboriginal flag flying, but preschoolers becoming activists ... I just smiled," he said.

The children had been taught respect for Aboriginal land during a campaign to get the council to put a bin on a nearby park that they were told was traditionally Cammeraygal land. "All of this began around the idea that there was an absence of respect," the spokesman said (Daily Mail, 2019, October 23).

Vignette 4

During an interview with ABC Journalist, Sarah Ferguson, for the television documentary series 'Revelation', with an alleged victim of child sexual abuse, 'Bernie' stated: 'I would hear Pell's become Bishop, Pell's become Archbishop, Pell's become a Cardinal. As he climbed his ladder, his stupid bloody Papal greasy ladder that he was climbing, it confirmed to me more and more, that I was never to come forward. (Crying) Who's gonna believe a little boy from a home against that conglomerate mate, you know, against that bloody

Goliath (Fulton, 2020, 26.37). Asked what he wanted to happen now that he had made his allegations public which he found very difficult '(Crying) I want to heal, now .... I've carried that burden for long enough; the shame, the embarrassment.... I wanna wake up tomorrow and I'm the Bernie I want to be, mate' (Fulton, 2020, 1:39.54).

Vignette 5

In the same episode, Ferguson interviewed solicitors who had represented victims and alleged victims of child abuse, who talked about the power shift they had noticed in recent times. 'The tables are turning. The power imbalance is beginning to shift' reported Judy Courtin, a solicitor in a historic child abuse case against the Catholic Church' (Fulton, 2020, 1:35.34). Another said 'A lot has been achieved because people have had the courage to come forward, and the children are finally doing now what the Catholic Church never did. They are coming forward and reporting matters to the police. And nothing is going to silence those voices now' claimed Dr Viv Waller, Solicitor for Witness J, the former choirboy who accused Cardinal George Pell (Fulton, 2020, 1:36.34). There were also those within the church's hierarchy who could see the magnitude of the problems involved now that the voices were gathering confidence, commented 'See they didn't have love (talking of those priests who have abused children). They had lust and kids need to be loved and not just by mum and dad. They need to feel safe and secure. If they are lusted after, they are ruined.... We're in a mess, aren't we?' (Fulton, 2020, 1:38.01). Archbishop Mark Coleridge speaking from the Vatican's Emergency Summit on Child Sexual Abuse went further, 'We are dealing with a global emergency (and I don't think that language is too strong), a global emergency that requires a global response' (Fulton, 2020, 9.03). He offered this prayer in the Vatican during the summit 'This homily is a meditation upon power. At the heart of what we call child abuse, there is power and its dark and destructive use.... We have seen victims and survivors as the enemy, but we have not loved them. We have not blessed them..... We will do all that we can to bring justice and healing to survivors of abuse. We

will listen to them, believe them, walk with them. We will ensure that those who have abused are never again able to offend' (Fulton, 2020, 1:39.23).

Vignette 6

The right-wing media journalist for Sky News, Andrew Bolt (Bolt, 2020), commented on the Australian High Court Decision on Cardinal George Pell's appeal, allowing him to leave gaol, 'This was one of the greatest miscarriages of justice in Australian history. A lot of people today should be ashamed of their role in the persecution, the witch-hunting and jailing, for 404 days, of an innocent man. The charges were inherently implausible (para. 2-4)'. In an interview with Andrew Bolt, Cardinal Pell (Pell, 2020) commented on why the alleged victim, Witness J, might have accused him 'I don't know. I wonder whether he was used. Our memory is so fallible. I don't know what this poor fellow was up to.' Cardinal George Pell speaking about former choirboy, Witness J who he was accused of abusing (Pell, 2020, 30.29). He then spoke more broadly about the issue of the silencing of children's voices and the issues of power 'The pendulum 30 or 40 years ago was massively against anybody who said that they'd been attacked. Nowadays, we don't want it to swing back so that every accusation is regarded as gospel truth. That would be quite unjust and inappropriate.' Cardinal Pell (Pell, 2020, 48.23). Pope Francis preached at a service for the pilgrims on the eve of the Vatican Emergency Summit into Child Sexual Abuse, saying 'You can't live all your life by accusing, accusing and accusing the Church. Who is the accuser? Who? Who in the Bible is called the Great Accuser? Who?...The Devil....they are friends, cousins and relatives of the devil and this is wrong' (Fulton, 2020, 13.08). He also offered this tweet after Cardinal George Pell was released from jail in April 2020 'Let us pray together today for all those persons who suffer due to an unjust sentence because of someone had it in for them' (Pope Francis @Pontifex, 2020).

Vignette 7

Around 15 years ago I was part of a consortium that successfully tendered for money from the federal government to research Indigenous communities around Australia to develop an Indigenous Child Care Plan (Saggers et al., 2006). At the time a number of Indigenous communities operated a Multifunctional Indigenous Children's Centre (MACC). These were funded separately from standard child care centres and ran a programme that not only offered child care for Indigenous children, but reached out into the community and supported Indigenous families in many different ways; programmes that were developed for each specific community to address specific community and family needs. As I understood the political landscape at the time, there was pressure to transfer the funding of these services to standard child care funding. I came to believe the subtext of the project was therefore to produce research that demonstrated such a transfer would be appropriate. However, what became extremely clear to the team as we travelled around the country visiting services and communities, was that transfer to hegemonic child care model and funding would result in significant diminution of services. In particular the unique outreach services offered at each MACC could not be supported if services were only funded based on the number of children attending each day. The report submitted made this clear and provided a range of evidence in support. The team were planning a range of publications based on their findings which they believed would honour the many participants who so generously provided their input. However, the report was embargoed and the team were unable to publicly share any of the findings. Indigenous agencies and MACCs continued to resist what amounted to a significant cut in their services for some years without the evidence accrued in the report to support them. Team members had to be very circumspect in their support of this fight, needing to ensure any information provided could be identified from sources other than the research and consequent report (for example Sims et al., 2008). Eventually the report was released under the FOI process, but this occurred much too late for the data to be of any use. Thus, the expenditure of a significant amount of government funds was ultimately not beneficial to Indigenous communities nor able to be used to develop effective Indigenous early childhood services.

Vignette 8

It is well known that more children with an Indigenous, rather than a non-Indigenous background continue to be removed from their families. In Western Australia, for example, in 2018 64.4/1000 children from Aboriginal or Torres Strait Islander backgrounds had been removed by the Western Australian Department for Child Protection compared to 3.6/100 children from a non-Indigenous background (Australian Institute of Family Studies, 2020). This discrepancy remains despite the existence of the Aboriginal and Torres Strait Islander Child Placement Principle, developed in the 1970s, which aims to maintain Aboriginal and Torres Strait Islander children's links with community and land through ensuring that family and community are involved in decisions related to children's welfare (Australian Institute of Family Studies, 2015).

Despite this principle, which might be perceived as reflecting the basic human rights of Indigenous children, the WA Parliament are currently debating the Children and Community Services Amendment Bill 2019 (WA) which specifies that an Aboriginal child may be removed from the family after consultation with only one family member and potentially one Aboriginal organisation (Noongar Family Safety and Wellbeing Council and Secretariat of National Aboriginal and Islander Child Care, 2020). Such a provision is not universal across Australia. For example in Victoria the Aboriginal Family-led Decision Making process emphasises the importance of the family group (that is more than one family member) and children's connections to community (Victorian Government Department of Health and Human Services, 2019). In their press release the Noongar Family Safety and Wellbeing Council and Secretariat of National Aboriginal and Islander Child Care (2020: 2) argue: "The proposed law goes against human rights principles set out in the UN Convention on the Rights of the Child and the Declaration on the Rights of Indigenous Peoples, which is supported by the Australian government." Whilst it is not yet clear if these Indigenous voices will be heard, and the proposed law voted down as a consequence, what is clear is that Indigenous voices were not sufficiently recognised in the drawing up of this proposed legislation in the first place.

Vignette 9

Over 25 years ago (10 August 1987) the then Australian Prime Minister, Hawke, announced he was forming a Royal Commission to investigate the deaths of Aboriginal and Torres Strait Islander people in custody in state and territory jails between 1 January 1980 and 31 May 1989 (National Archives of Australia, 2020). In total, 99 deaths were investigated, and the Commission generated 339 recommendations aiming at reducing the high number of Indigenous deaths; at the time it was estimated that one Indigenous person died in custody even 11 days (Anthony, 2016). The findings identified that the higher rate of death of Indigenous people in custody was because Indigenous people were much more likely to be in custody than non-Indigenous people. The reasons for this higher incarceration rate were attributed firstly to police prejudice, where minor crimes such as being a public nuisance, or being intoxicated in public, were more likely to result in jail time for an Indigenous person. Secondly, Indigenous people were more likely to be arrested than warned by police. Thirdly, Indigenous people were less likely to be given bail, and finally, more likely to be given custodial sentences by the court system. The findings also highlighted a lack of care of Indigenous people in custody and stories of police abuse and mistreatment.

Unfortunately, despite the aim of the many recommendations arising from the Commission, the reality today is worse. In 1991, Anthony (2016) reports Indigenous people made up 14% of the total prison population, whereas by 2016 this figure had increased to 27% but in 2016, Indigenous people made up 3.3% of the total Australian population (in 2016, Indigenous people made up 3.3% of the total Australian population: Australian Bureau of Statistics, 2018). Since the Commission, the government has continued to increasingly "penalise vulnerable Indigenous people (by removing children from their families, criminalising youth and women victims of family violence, and locking up the mentally ill)" (Anthony, 2016: 4). At the same time, funding has increasingly been removed from Indigenous organisations with the aim of moving Indigenous services into the mainstream, resulting in the reduction of Indigenous representation and Indigenous voice.

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From Confusion to Clarity: Two Early Years Teachers' Remote Learning Experience

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Abstract

Just as students experience productive struggle or spend time in the 'zone of confusion' when engaging with challenging tasks, teachers also experience similar difficulties and periods of confusion when engaging with new pedagogical approaches. Prior to a 19-week lockdown due to Coronavirus (COVID-19) during 2020, two Foundation teachers implemented a student-centred pedagogical approach when teaching with challenging tasks. While they had some initial success implementing the pedagogical approach and a three-phase lesson structure, they struggled to do so online during the lockdown. It is the experiences of these teachers, in particular their experience of confusion relating to aspects of the pedagogical approach, and how this confusion was overcome, that is reported in this paper. Central to our findings is the importance of teachers reflecting on their own experiences of struggle and the impact this had on their professional learning, as well as the notion that adversity can be a catalyst for change.

Keywords:
COVID-19, Early Primary Teachers, Mathematics Education, Remote Learning, Productive Struggle, Pedagogical Practice, Organismic Valuing Theory Of Growth

Introduction

The Coronavirus (COVID-19) pandemic impacted on schools across the world requiring teachers and students to shift to remote (online) learning. Within Australia, Victoria had to endure remote learning for a much longer period than other states during 2020: two weeks of Term 1, the majority of Term 2, all of Term 3, and the first week of Term 4, a total of 19 weeks of a 41 week school year. This required a considerable adjustment for teachers, students and parents alike. While several studies have been reported within Australia and internationally (e.g., Flack et al., 2020; Hamilton et al., 2020) about teachers' experiences of having to adapt to teaching remotely, the teachers' experiences in the current study were distinctive in that they were engaged in a professional learning project involving teaching with sequences of challenging tasks at the time. A central focus of the project was to support teachers to make stronger connections between their pedagogical content knowledge and the way it is enacted in their mathematics

classrooms. Embracing and exploring a different pedagogical approach takes time and requires support. However, as indicated in the literature, the resources needed to support teachers to implement a new pedagogical approach were diverted during remote learning because of other issues (e.g., Lepp et al., 2021).

To our knowledge there are no studies within Australia or internationally that have reported on the impact of COVID-19 on the teaching and learning of mathematics in the early primary years of school (Foundation to Year 2- the first three years of school). As such we consider this study makes a unique contribution to the research literature. We offer an account of two early years primary teachers' experiences of pursuing a pedagogical approach to teaching mathematics focussed on teaching with sequences of challenging mathematical tasks during remote learning.

To inform our study, we drew on research literature relating to teachers' experiences during remote learning, parent support and home learning environment, teaching with challenging tasks in classrooms, and online during remote learning.

Review of the Literature

Teachers' experiences during remote learning

While several advantages of online learning for teachers have been highlighted in the literature such as accessibility to learning from regional and remote settings, no commuting, time saving, opportunities to remain in touch with teachers and classmates in an online space (Sadeghi, 2019), there are limitations. These include: a lack of resources, limited physical space for home–based learning, no social interaction with peers, and feeling isolated (Sadeghi, 2019). In essence, these challenges can be categorised according to three key components: 1) technology- access to the infrastructure; 2) pedagogies- teaching materials to engage and maintain students' motivation, lack of student feedback and opportunities for formative assessment; 3) social challenges – suitability of home learning environment, and parent support, as parents are unsure of how to assist their children (Ferri et al., 2020; Yusouf & Ahmad, 2020).

As reported by United Nations Educational Scientific and Cultural Organization (UNESCO, 2020), one of the consequences of school closures, due to COVID-19, was the confusion and stress placed on teachers due to the abruptness of the closures and uncertainty about the duration of remote learning. Moving to remote learning was a steep learning curve for teachers having to develop new skills and expertise in a short period of time (Kim & Asbury, 2020). These authors also noted an additional stress for some teachers was the competing responsibilities, such as having to home school their own children. The shift to remote learning also disrupted a core aspect of teacher identity – that of interpersonal connections, such as relationships with colleagues, students and parents (Goe et al., 2008). Related to this were potential disruptions to teachers' use of reflective practice, whether it concerns their pedagogical approach or how they engaged with parents, students and colleagues (Kim & Asbury).

Kim and Asbury (2020) conducted a study in England to explore twenty-four primary and secondary teachers' experiences during the first six weeks of partial school closure. They conducted semi-structured interviews via Zoom with the teachers relating to a high point, a low point, and a turning point in their practice during remote learning. Six themes were identified from the analysis, one of which was the importance of relationships. Teachers reported that their relationships with students, parents and colleagues had been disrupted, which they described as a low point in their experience of remote learning. For example, some teachers commented on students' lack of engagement or parental complaints. However, other teachers instead commented on innovative ways they had engaged families, such as setting up a Facebook group. Another theme that emerged was teacher identity. Many teachers commented on how their teacher identity had been affected by COVID-19. Teachers in the study did not use any synchronous learning, rather narrated PowerPoints, videos, and educational websites and hard copy work packs. While acknowledging that remote learning presented major challenges, Kim and Asbury noted that when given an opportunity to reflect, several teachers commented that they had the opportunity to be creative and to differentiate students' learning in meaningful ways, and engage with students on a one on one basis. Others commented that the reflection on their teaching during this time enabled them to consider whether some of the changes implemented during remote learning might become part of their practice post COVID- 19 education.

Almost 50% of respondents of a survey conducted in Ireland relating to primary school teachers' remote learning experience indicated that mathematics was the most difficult subject to adapt to online learning (Burke & Dempsey, 2020). Contributing factors were that parents and teachers were not equipped to provide online learning, and parents lacked confidence with the content. Some teachers reported that about a third of the parents expected their children to complete the work by themselves, another third was overwhelmed and a third did not engage with their students' during remote learning. Similarly, results of a survey of 505 teachers in the United States (USA) indicated that 83% of teachers were finding it more difficult to enact their craft during remote learning (USA TODAY & Ipsos, 2020).

An important aspect of mathematics learning is the social interaction, which has been found to have a direct impact on students' engagement with mathematics (e.g., Boaler, 2000; Middleton, 2013; O'Toole & Plummer, 2004). Several studies reported that remote learning negatively impacted on student learning due to the social isolation and social disconnection (Burke & Dempsey, 2020; Flack et al., 2020). Other studies reported that limited social interaction with teachers and peers during remote learning impacted students' social and emotional well-being and the quality of the teacher-student relationships (Kamei & Harriott, 2020; Pecjak et al., 2021). Further, Flack et al. found that many participants in their study believed there was a causal link between social interaction, well-being and student learning outcomes.

Parental support and home learning environment

Several scholars reported on the need for parent support and involvement during remote learning. Parental involvement in their child's regular face-to-face learning varied due to parents' work commitments, family background, and socio-economic status (Di Pietro et al., 2020). In remote learning parental involvement was necessary, particularly with younger children who do not have independent learning skills, or social maturity to apply themselves in a virtual learning environment for long periods of time. However, it is important that learning at home is designed in such a way that maintains students' independence, which is essential for cognitive development (Hwang & Hariyanti, 2020).

The literature indicates many disparities were evident in terms of the parent availability to support their children's learning, including: their inability to work from home. For example, parents did not possess the necessary technological skills or in the case of less advantaged parents did not have the cognitive, social-emotional abilities or sufficient command of the English language to assist their children (Attanasio et al., 2020). A related factor was whether the home environment was conducive to online learning (Di Pietro et al., 2020). The availability of digital resources, including the use of a laptop or computer at home and access to reliable broadband internet were important in remote learning, as these were the main avenues of communication between students and teachers. Data from the Australian Bureau of Statistics (2018) indicates that on average 13.2% of households in disadvantaged areas do not have the Internet (Drane et al., 2020). Related to this are the skills, expertise and confidence of children, parents and teachers to use a digital platform for learning.

Communication with parents about their child's learning is important. During regular face-to-face learning it is a combination of informal discussion, such as before and after school or via face-to-face formal meetings. During remote learning, ongoing communication with parents was essential, some of which occurred via the phone rather than the Internet, others via a daily post on the school's website, email, or ClassDoJo (school-based community platform). However teachers found this challenging and time consuming (Burke & Dempsey, 2020).

The review of literature relating to remote learning highlights some key points. First, moving to remote learning is a steep learning curve for teachers, as they need to develop new skills and expertise and pedagogies to engage and maintain students' motivation, and differentiate the learning. Second, as well as considering their own practice and student engagement, teachers also need to consider parents and how they will support their child's learning in a way that the child's independence is maintained. The third consideration raised relates to the actual technology, the resources required and the technology skills of parents to support their child's learning. These factors were considerations of the teachers reported in the current study, in particular how to transfer new learning to a remote learning environment.

Teaching with challenging tasks and inquiry-based mathematics learning

Current theories for teaching include the use of highly cognitive demanding tasks or challenging tasks, which are designed to promote rich student-centred learning (Sullivan et al., 2011). Challenging tasks are open-ended in nature, engage students in problem solving, and are acknowledged to incorporate high cognitive demand (Middleton, 1995). Teaching with challenging tasks requires a different lesson structure and approach from one that starts with teacher modelling or telling students what to do, which is recognised as reducing the opportunity for productive struggle and the cognitive demand of tasks for students (Roche & Clarke, 2014). Aligned with this is a tendency for teachers to reduce the demand of tasks when planning (Tzur, 2008) and over explain how to respond to tasks during lessons (Stein et al., 1996).

The lesson approach Sullivan et al. (2015a) advocated when teaching with challenging tasks includes a three-phase structure: Launch, Explore, Summarise. The teacher presents the task in the launch phase with no explicit instruction and students are expected to attempt the task by themselves. Initially, students are expected to spend some time in the "zone of confusion" as they grapple with the task (Clarke et al., 2014, p. 9). After students make an initial attempt at the task, they may be provided with an enabling prompt as a sub-task if they are struggling to make progress or an extending prompt once they have completed the task (Sullivan et al., 2006). During the Explore phase the teacher monitors and identifies students to share their working out. In the Summarise phase, the teacher

pauses the lesson and invites students to share their thinking, reasoning and strategies. This phase may occur multiple times during the lesson as it affords students opportunities for peer learning and allows the teacher to support students to make rich connections to the underlying mathematical concepts.

Teaching with challenging tasks and inquiry-based mathematics learning in remote learning settings

Recent studies have considered the shift to remote learning as a consequence of the COVID-19 pandemic, and its impact on teachers pursuing inquiry-based pedagogical approaches, such as teaching mathematics through challenging tasks. In particular, Kalogeropoulos et al. (2021) reported on mathematical experiences of teachers and students from two Australian primary schools that emphasised inquiry-based approaches. These authors explored the extent to which various 'sociomathematical norms' (Yackel & Cobb, 1996) central to effective inquiry-based mathematics classrooms transferred to a remote learning setting. Analysis of teacher interview data and student questionnaire data revealed that providing students with choice over both the tasks they undertook and the level of challenge pursued appeared to effectively translate to remote learning settings. By contrast, opportunities for students to collaborate with peers and discuss the mathematics were more difficult to translate in an online setting. The authors concluded that lack of opportunities for peer support and collaboration had negative implications for student engagement and learning. This is not surprising given that other research suggests that opportunities to explain their thinking and learn from peers are classroom events that students strongly attribute to supporting their mathematics learning, and central to effective mixed-achievement mathematics teaching (Clarke, 2021; Kaur et al., 2013).

Another potential obstacle to implementing challenging, inquiry-based learning approaches in a remote learning setting is the fact that such environments place parents in the role of 'pseudo-teacher'. Parents may have little sense of the value of such approaches to teaching mathematics and be reluctant to allow their children to struggle productively with mathematical tasks, and 'hold back from telling' (Roche & Clarke, 2014). Indeed, as reported previously, the negative attitudes of parents and carers towards allowing their children to struggle when learning mathematics and the absence of a teacher-facilitated, synchronous, learning environment were found to be the two major impediments to productive struggle in remote learning settings in our project (Russo et al., 2021).

Theoretical Framework

It is interesting to consider what our initial assumptions might be about the impact of the COVID-19 pandemic on the experiences of teachers undertaking professional learning involving exposure to a new pedagogical approach; specifically, teaching with challenging tasks. Perhaps most straightforwardly, it might be expected that the dramatic shift to a remote learning environments would undermine teachers' capacities to devote resources to exploring and experimenting with new pedagogical approaches, as resources have been diverted to address issues such as the wellbeing of students, colleagues and parents (Lepp et al., 2021), and teachers educating one's own children remotely (McLennan et al., 2020). This is consistent with the perspective that a lack of time and access to resources more generally is one of the most significant impediments to implementing reform-oriented approaches to mathematics teaching (Day, 2020; Sullivan et al., 2015b). In addition, as it is unlikely that the pedagogical approach being experimented with in this study was developed with remote learning in mind; reimagining this pedagogy in a remote learning environment would most likely require a substantial investment of time and energy. To summarise, this resource-diversion perspective would suggest that teachers will be highly reluctant to explore new pedagogical approaches during remote learning, particularly approaches that do not seamlessly translate to a remote environment, such as inquiry-based mathematics approaches (see Kalogeropoulos et al., 2021).

Conversely, it could be argued that an adverse event such as the COVID lockdown and the shift to remote learning could be a potential catalyst for teacher professional growth because it prompts introspection and encourages teachers to re-examine previous assumptions and modes of operating. This position has some support within the psychology literature, where several theories of growth through adversity have been proposed (Joseph & Linley, 2005; Nerken, 1993; Tedeschi & Calhoun, 2004). In particular, Joseph and Linley's (2005) organismic valuing theory of growth through adversity posits that, "people are intrinsically motivated toward rebuilding their assumptive world in a direction consistent with their innate tendency toward actualization" (p. 276). The theory suggests that individuals who are able to restructure their existing knowledge base to accommodate new information revealed through the adverse event (accommodation) are more likely to grow personally through this event than individuals who try and modify this new information to fit within their existing knowledge base (assimilation). The corollary is that those individuals who can positively accommodate this new information are in a position to achieve

a higher level of personal functioning, than if they had never encountered the adverse event in the first instance (Linley, 2004). The extent to which an individual is able to achieve positive accommodation and grow through the adverse event is influenced by several factors, including whether their social environment is "facilitative of their fundamental psychological needs of autonomy, competence, and relatedness" (Joseph & Linley, p. 274).

The organismic valuing theory of growth has been used to explore changes in teacher knowledge and skills following remote learning brought about by the COVID-19 pandemic. Specifically, Dewi-Izzwi et al. (2020) found some support for the theory when analysing the responses of Malaysian educators (primary teachers, secondary teachers, university lecturers) to a questionnaire that asked them to reflect on changes to their practice following the shift to remote learning. Of the 148 respondents, over 90% indicated that they had learnt new skills and gained new knowledge, whilst more than 80% indicated enhanced creativity as an educator. Overall, almost two-thirds of respondents indicated that they felt they were now a better educator than before having experienced remote teaching.

The current study

The aim of the current study was to investigate whether teachers of Foundation students (5-6 years of age), engaged in a professional learning project involving teaching with sequences of challenging mathematical tasks, would embrace the approach during remote learning, or would modify the new learning to fit with their existing practice. Underpinning this study is Joseph and Linley's (2005) organismic valuing theory of growth, and the notion of growth through adversity and adverse events. The specific research question being investigated was:

> *How did remote learning impact Foundation teachers' implementation of a new pedagogical approach to teaching mathematics?*

Method

The research design was a case study of two Foundation teachers' experiences during remote learning. Yin (2009) states that case study research is suitable for explaining a specific circumstance through providing an in-depth description. The case study is both teachers' accounts of their experience as captured via two online Zoom meetings by the researchers. Note that Foundation is the first year of formal school in Australia, and most students commence Foundation at five years of age. The two teachers were selected as they were endeavouring to use a new pedagogical approach in a remote learning setting.

Background to the study and participants

Schools within Victoria moved into remote learning (learning from home) in March (Week 9 of Term 1, a 10 week term) and continued to do so for the first six weeks of Term 2 (an 11 week term). Remote learning took different forms, as there was no mandated directive from either state or federal education departments. This allowed schools and teachers the flexibility to meet their student learning needs in whatever way they saw fit. Teaching advice and technical support was provided at the school level. Some year levels focused on asynchronous learning where students were provided with the day's content via the school's online communication platform (e.g., Seesaw). Students might start the morning by attending an online briefing session with the teacher, then work independently with support of a parent or carer. Other students watched a series of videos prepared by the teacher before or after engaging with the learning. Some teachers had 30-minute synchronous sessions with their students for literacy and numeracy learning each day or on alternate days, where they provided feedback to students on their learning.

The two Foundation teachers reported in this study were part of the Exploring Mathematical Sequences of Connected, Cumulative, and Challenging Tasks (EMC3) project which adopts a student-centred, structured inquiry approach to the teaching of mathematics (Sullivan et al., 2020b). There were 102 early primary years teachers (Foundation to Year 2) participating in the project that consisted of two professional learning days, one at the beginning of the year and one at the end. The first professional learning day was in February and was face-to-face, prior to COVID-19 restrictions; the purpose of which was to share the underlying philosophy, introduce the enactment of challenging tasks, model the lesson structure approach, and engage teachers in examples of tasks for selected sequences of challenging tasks. Teachers were given a resource booklet that included the sequences of challenging tasks and related pedagogical advice. The purpose of the end of year professional learning day was to celebrate the learning and the insights gained from the experience of teaching with sequences of challenging tasks. This second day occurred online, in November.

Following the first professional learning day, members of the research team supported the teachers with facilitated planning sessions in their schools. During the facilitated or co-planning stage, teachers first engaged with the tasks independently. This was followed by collective discussion of key mathematical ideas, anticipated student responses including potential misconceptions, generation of questions to stimulate student thinking, and ways to differentiate student learning. The intention was for the teachers

to experience a modelled lesson and/or co-teaching of lessons subsequent to experimenting with the co-planned lessons in their classrooms. Unfortunately, due to the onset of COVID-19 this aspect of the professional learning support did not eventuate.

The two Foundation teachers, Susan and Jessie (pseudonyms), reported in this paper were employed in a small Catholic primary school in an affluent suburb of Melbourne. Susan had more than 10 years of teaching experience, whereas Jessie was a graduate teacher. The total population of the school was 144 students and each of the Foundation classes had 11 students in 2020. The school's Index of Community Socio-Educational Advantage (ICSEA) percentile was 93 with 60% of student families belonging to the top quarter Distribution of Socio-Educational Advantage (SEA), and 33% of the students had a language background other than English.

Data collection

Two researchers (authors 1 & 3) provided support to the project school in which Susan and Jessie taught. Due to the COVID-19 restrictions (late term 1), planning and support relating the implementation of the sequences occurred online during terms two to four (periods of the school year). For the study reported in this paper, data were collected via two Zoom online meetings related to the teachers' 'lived experiences' of implementing the sequences during remote learning. Both sessions were audio recorded and the data transcribed. Examples of questions that guided the discussion included:

- What were the challenges with transitioning your teaching of a sequence to remote learning?
- Did any students surprise you through doing the tasks independently prior to the lesson?
- Was there a particular task that was initially unsuccessful when taught online in terms of intended student learning and what happened as a result?
- Describe a task that was highly successful (online). What were the reasons for this? Did you teach the subsequent consolidating task (similar task)?
- From your online experience what did you bring back to the classroom in relation to pedagogy? In what ways have you adapted your planning as a consequence of engaging in online teaching?
- If you were teaching the sequences with Foundation students next year what aspects of your practice would you like to focus on improving or embedding more deeply?
- Do you believe that exploring the sequences in remote learning contributed to any changes in your teaching practice more generally?

Our online meetings primarily inform the current narrative account with participants, as did the researchers' (authors 1 & 3) reflections on the teachers' account and the importance of providing professional learning support to the teachers.

Data analysis

We adopted a narrative approach when collecting and analysing data to inform our study (Connelly & Clandinin, 1990). A narrative approach has several advantages as a method within educational research, including providing thick descriptions of events that support in-depth data analysis and the fact that human beings are naturally inclined towards both communicating and digesting stories (Butina, 2015). As noted in the research literature, validity, in the context of narrative-based research, is concerned more with the research being well grounded and supported by the data collected, than providing results that produce generalisable truths (Webster & Mertova, 2007). Given the purpose of our study was to examine how the rather dramatic shift to remote learning because of COVID-19 impacted on the professional learning journey of Susan and Jessie, a narrative approach that captured their experiences over time in relation to this significant event seemed appropriate.

Authors 1 and 3 undertook the coding process independently initially, by reading and re-reading each of the transcripts and highlighting key words or phrases that provided a sense of the teachers' experiences in each stage of their journey. The second step was to use the phrases and words identified to create broad themes. The third step involved the two authors sharing their independent coding and how they arrived at the themes, and then together reached agreement about the overarching themes. Coding the data independently initially, then discussing and deciding on the themes collaboratively, served to enhance the validity of the inferences being drawn (Creswell, 2013).

The overarching themes included: student access to resources during remote learning; organisational issues related to synchronous teaching; enthusiasm of the teachers; parents (communication, intervention, understanding of task and approach); adapting pedagogical approach for remote learning; student interaction and discussion.

Contexts and Events of Remote Learning

A week after the professional learning day Sally (third author) conducted a planning session with Susan and Jessie focusing on the Counting Principles sequence. Doing so included identifying the key mathematical

ideas, anticipating what students might do and planning enabling and extending prompts. Sally highlighted the important pedagogical actions, in particular the launch without telling and allowing students time to struggle. The teachers responded enthusiastically as Sally recounted:

> *I had a really good planning session with the Foundation teachers today; they loved the resource book and are keen to get started. I hope to model some lessons before the end of term.*

The School Mathematics Leader (Karen) said that the students engaged really well and the teachers enjoyed the experience (email correspondence). Sally was scheduled to model three lessons during the next school visit in March and help the teachers to plan for the rest of the school term. However, due to the unexpected chain of events as a result of the COVID-19 pandemic, this did not happen. Consequently, the teachers were required to do subsequent planning without external support.

Remote Learning 1 – Term 2 (April 15- May 23), Weeks 1 – 6 inclusive

Following their success, Susan and Jessie were keen to explore initial tasks in the Making Things Equal sequence, during the first remote learning period. The mathematical focus of this sequence is equivalence and a key recommendation for developing the idea of equivalence is to use kinaesthetic approaches, tactile objects and visualisations. The first suggestion in the sequence is the 'Cakes 1' task (Figure 1). It is intended that the students find multiple possibilities for making the plates equal and in so doing explore informal concepts of addition and subtraction, as well as equivalence.

A key aspect of the learning is for students to recognise that collections can be compared without necessarily counting by ones and made the same by adding or subtracting items. A task such as this (Figure 1) is fundamentally about developing young children's understanding of the meaning of equivalence using a real life context. Because some of the ideas underpinning the tasks are complex, it is intended that teachers consolidate the learning by engaging students in subsequent tasks which are essentially the same task but use different numbers (Sullivan et al., 2020b).

Both teachers considered the task seemingly self-explanatory and uploaded the task sheet to Seesaw (an online digital platform the school used to communicate with students and parents). The only instruction provided to the parents was to read the task to their child. The students were required to complete the task at home without any synchronous interaction, as the teachers wanted to implement the launch, explore, summarise lesson structure and considered that requiring students to 'have a go' on their own was similar to the launch phase in face-to-face lessons. Students were required to upload their completed work onto Seesaw for the teachers to assess.

A key aspect of the EMC3 approach is the summarise phase of a lesson; however there was not an opportunity for Susan and Jessie to enact this with the students in the online space, as there were no dedicated synchronous learning sessions. Critical to students' developing understanding, which in this scenario was equivalence, is discussion with peers and teachers. Another key to supporting students' learning of equivalence is to use a kinaesthetic approach, however neither Susan nor Jessie had considered this when conveying the task to the parents and students.

Rather than giving the students a consolidating task from this first suggestion, which was a variation of the Cakes 1 task, the teachers chose to progress to the second suggestion in the sequence. The task involved making collections equal by adding or subtracting items, in this case, moving marbles to one side of a

Figure 1.
Cakes 1 task

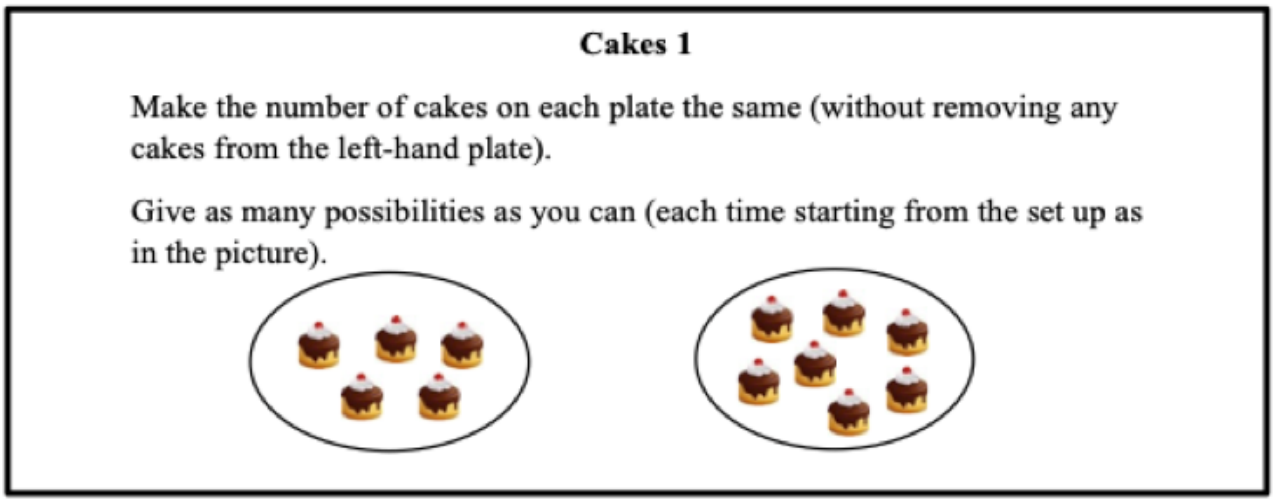
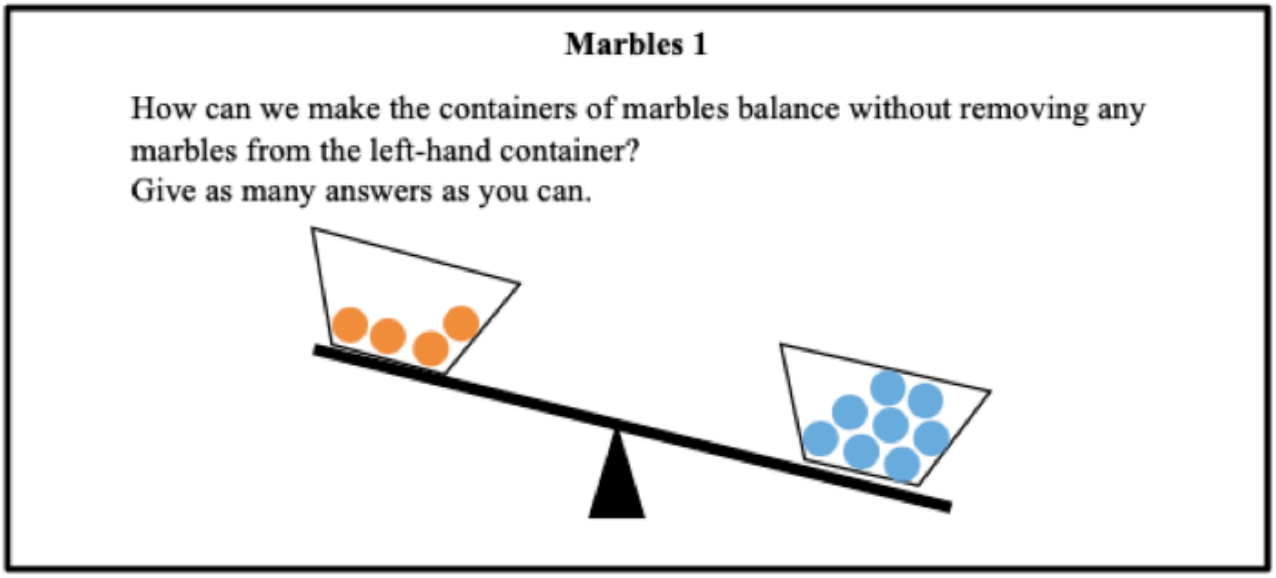


Figure 2.
Marbles 1 task



balance beam, from the other side. The intention of the second sequence was to provide an opportunity for students to consolidate their learning by exploring the same concept in a different context using a somewhat different representation (see Figure 2).

Students were encouraged to draw pictures to represent their thinking or to use the template provided. Susan and Jessie used the same approach as they did with the Cakes task. However, it was only when some parents raised concerns that their child was struggling, and required assistance in how to solve the problem that the teachers realised there was an issue. In supporting their child, parents drew upon their own experiences of learning mathematics and were not familiar with open tasks and the prospect of multiple answers.

The teachers had not anticipated the need to put structures in place for parents to support their children's learning, in particular some suggestions of materials they could use such as coat hangers and pegs to simulate a pan balance. Following this experience, the teachers decided to abandon teaching with challenging tasks for the remainder of Remote learning 1 and instead used a more traditional approach to teaching addition and subtraction, rather than focus on equivalence.

Unfortunately, Sally did not have the opportunity to meet with Susan and Jessie prior to Remote Learning 1 to advise them on the choice of sequence to explore during the remote learning nor to discuss ways to approach online learning. Consequently both teachers were in the 'zone of confusion' as they had not realised how they could transfer their learning of the lesson structure and the project's underlying philosophical approach to an online remote learning setting. In addition, they had not anticipated the need to inform the parents about the pedagogical approach they were exploring.

Students in Foundation – Year 2 returned to face-to-face learning for the last three weeks of Term 2. During this time the focus was on re-establishing classroom routines, assessment and ways of learning, which was particularly important for the Foundation students who had only experienced face-to-face learning for the first eight weeks of the school year.

Post Remote Learning 1 reflection and return to remote learning

Term 3 commenced with teachers preparing to return to remote learning (Remote Learning 2); the school holidays were extended for students, and teachers were given a week for planning future lessons. In the first four weeks of Term 3 during the second lockdown Susan and Jessie returned to a more traditional approach to teaching mathematics that they used in the latter weeks of Remote Learning 1. However, in Week 5 they met with us (authors 1 & 3) to discuss planning for the remainder of the term. This provided Susan and Jessie with an opportunity to reflect on their remote learning experiences and to consider how they might explore a sequence during the extended remote learning period in Term 3. The following account relates to Zoom video meeting with the teachers during remote learning when we provided suggestions as to how they might proceed during the second phase of remote learning,

The teachers recognised the benefits of teaching with challenging tasks in a classroom setting from their initial experiences prior to remote learning. They originally thought the tasks could be transferred to a remote setting, without consideration of the significance of the lesson structure and pedagogical approach. It was only after they attempted to implement some of these tasks remotely that they became aware that these elements are critical to supporting student learning. An opportunity to reflect on their online

teaching experience with us allowed both teachers to identify key components critical for successful implementation of the tasks, which included:

- informing parents about the pedagogical approach, including the need to hold back and allow students to struggle;
- informing the parents about the nature of challenging tasks and the importance of generating multiple solutions and/or different strategies;
- providing suggestions for alternative concrete materials to use, as well as enabling and extending prompts; and
- orchestrating student discussion about the mathematics including the careful selection of student work samples to stimulate thinking.

Teachers' comments related to these components included:

> *I was wondering how you would do these lessons at home when parents are probably going to be supporting [learning] and you know even pushing their child to a particular answer and way of doing something. (Jessie)*

> *Parents intervened too much when they were learning from home and needed explicit instructions [including telling them to struggle] so that the students could learn. (Jessie)*

> *Parents had a big impact in the role during remote learning. We had to teach the parents about what EMC3 maths looks like compared to how they might have been taught. It was a big learning curve for them that there were multiple answers and many different ways to get to the same conclusion. (Susan)*

> *We learnt that our instructions for teaching the lesson had to be for the parents. (Susan)*

> *Towards the end we were sending huge emails that almost outlined our planner for parents to follow and communicated our expected learning for each task. (Susan)*

> *Students didn't have peers around them to learn with/from. (Jessie)*

Through reflecting on their experiences, the teachers realised the impact of the absence of real-time, synchronous interactions to allow students to discuss the mathematics and interact with their peers. Importantly, they recognised the need to restructure their approach to online teaching to accommodate these aspects. We supported Susan and Jessie with planning the Structure of Number sequence (see Russo et al., 2019 for a summary of the sequence); the intention of which was to revisit addition and subtraction as well as the opportunity for the teachers to put their learning from the Remote Learning 1 experience into action. Some of the discussion during this planning session related to trying out different approaches as evident from the following exchange between Susan and Jessie:

> *Susan: Do they [the students] need to do the task in a focus group first and then let them do it independently because we have both focus groups and online site where we post lots of videos?*

> *Jessie: I think that if we did the video and then the summarising part as part of the focus group I think we'd get a lot more rich language out of them, after they'd attempted it.*

> *Susan: We've had a few goes at getting them to record what they're thinking but we get less of a response when we do that than when we get them to take a picture of something that they've done, so the focus group would be a good opportunity for them to tell us what they're thinking.*

The teachers decided to divide the class into smaller groups, and launch the same task three times with different groups of students online. Following initial independent thinking time after the launch, students had the opportunity to share their initial thinking with the group. Students then worked offline independently on the task and recorded a range of solution strategies, which they uploaded through Seesaw. Susan and Jessie had an opportunity to review student work overnight, before engaging with their students online the following day to enact the Summarise phase of the lesson and launch a follow up consolidating task. Sometimes they used a video recording to launch the consolidating task.

Figure 3 shows how the teachers adapted the three-phase lesson structure during Remote Learning 2. There were two significant changes the teachers made to their pedagogical practice during the second remote learning period. The first was to extend the exploration of a challenging task across two days rather than one, and the second was to adapt the three-phase lesson structure to accommodate the different modes of delivery -synchronous and asynchronous, across two days.

Figure 3.

Adaptation of three-phase lesson structure for remote learning

Learning Mode	Day 1	Day 2
Online, synchronous learning (approximately 25-30 minutes)	Check 1 Game / Tuning in (approx. 10 min)	Discussion / Summarise from previous day (approx. 15-20 min)
	Launch challenging task, Independent thinking and initial share (approx. 15-20 min)	Launch consolidating task (approx. 10 min)
Offline, asynchronous learning	Explore	Explore
	Sample uploaded	Sample uploaded

In conjunction with the initial exploration that students had with their teacher, detailed information was sent to parents explaining the project approach and the type of guidance that parents could give their children. It was particularly important that parents realised that struggle was part of the learning process and to allow their child time to experience some initial confusion or uncertainty about how to proceed with the task; to encourage their child to look for more than one possible answer; and to record their thinking predominantly in drawings and words rather than using formal mathematical equations.

Another part of the online meeting with Susan and Jessie related to assessment. We suggested that when the students returned from remote learning the teachers re-engage the students with tasks from the Structure of Number sequence taught during Remote Learning 2.

Post Remote Learning 2 reflection and returning to face-to-face teaching

Students returned to face-to-face teaching in Term 4, and during the first four weeks Susan and Jessie revisited some Structure of Number tasks explored in remote learning, as well as additional tasks within the sequences that had not been taught during remote learning. The reasons for doing so included: to initially compare the students' responses for assessment; to ascertain how much parental influence was evident; and to provide students an opportunity to re-engage with each task in different ways (Sullivan et al., 2020a). The teachers were aware that some parents were possibly overzealous in their support.

> Some questioning of who was doing the work; it was a bit of a mishmash of what was authentic work and what was not. (Jessie)

In Week 5 of Term 4 we met with Susan and Jessie to reflect on student learning, and the teaching of the sequence during Remote Learning 2. We asked them to describe a task that was highly successful during remote learning.

> *Summer time is fly time! The students were drawing the wall, showing they were visualising the question. They explored the task across the week. We know some of the parents were quite involved in the tasks but overall it was a successful start to the subitising [task]. Once they progressed to the donuts task they had quite a good idea about how to approach it. (Jessie)*

> *Repeated the task and compared the work samples from remote learning to in school and it was evident the work samples represented the student thinking. There were only a couple of children who struggled to complete the task and these were ones we anticipated. (Susan)*

Some key points from these reflections included the need to slow down and explore a task across multiple days in a remote learning context; for parents to have an understanding of the task; and the teacher's pedagogical approach. The teachers also indicated that they did some consolidating tasks in the synchronous sessions (e.g., Playtime, and Fish) and some were completed remotely (e.g., Flies and Donuts). They were aware of the need for a blended approach, and being flexible with both delivery and structuring of the content (Burke & Dempsey, 2020).

> *We did some during the live lessons – Playtime was first as a live activity, flies were remote. (Jessie)*

> *The fish task was live [online] and donuts task was remote [independent task]. (Susan).*

We asked the teachers to consider the challenges and successes from the remote learning experience, particularly related to teaching with sequences of challenging tasks.

Challenges

When asked to reflect on the challenges with transitioning the teaching of a sequence to remote learning the teachers indicated that they had been adaptive in their teaching and planning. Adapting their practice was evidence of teacher noticing, an important aspect of teacher reflection (Eden, 2020), in that they noticed, interpreted what was happening and responded. They described the difficulties and constraints of the technology and having to adjust activities that ordinarily would involve concrete materials to learning through digital devices and everyday resources in the students' homes.

> *How to do hands-on activities through digital devices; this meant adjusting plans particularly for students who need concrete materials and thinking about alternative resources students would have at home to use. (Susan)*

Engaging with a new pedagogical approach was also a challenge for both the teachers and the students, as explained by Susan:

> *Making things equal, [they] were the big focuses and introducing the concepts and the big idea that they have to struggle and that was a big struggle and then we've got back to the addition and subtraction in a more traditional way during term 2 when we went into lockdown.*

They also recognised the importance of students being surrounded by their peers for opportunities for peer learning (Burke & Dempsey, 2020: Kalogeropoulos et al., 2021). Even when students were organised into small groups for online synchronous learning it was difficult for students to share their recording of thinking online:

> *Even when in small groups for online it was very difficult for students to see what others were recording and sorting their ideas on paper. (Jessie)*

An initial challenge they identified was how they would explore these lessons remotely in partnership with the parents, as indicated by Jessie:

> *I was wondering how you would do these lessons at home when parents are probably going to be supporting and you know even pushing their child to a particular answer and way of doing something.*

As previously described, as a consequence of these aforementioned challenges, the teachers decided to revert to a more traditional approach to teaching mathematics during the first lockdown.

Successes

Following an initially challenging experience with teaching online during lockdown, a facilitated planning session with the research team (authors 1 & 3) in Week 5 of Term 4 re-invigorated and stimulated both teachers' enthusiasm and perseverance to persist with challenging tasks during remote learning:

> *My brain is going a hundred miles an hour now. Just filling out that template and seeing how they get engaged with all the different tasks. I loved the first time that we explored this and teaching it and hearing all their different ideas come out, seeing the quieter students just come alive because they actually contribute more to a discussion. I'm looking forward to seeing this in action, especially online. (Susan)*

During remote learning, after the facilitated planning session, a task was explored across multiple days to allow the students to share their learning in each small group synchronous session. This effectively slowed down the learning and allowed for greater depth of student thinking. There was evidence of both teachers embedding new pedagogies into their practice, as they identified the importance of questioning and student discussion for each lesson:

> *During remote learning students really missed this opportunity (for discussion) and it really did make an impact not having that there. (Jessie)*

> *We have really kept that pedagogy of really thinking about the questions and how to extend the students or enable them. (Jessie)*

Trialling of a unit planner that contains key aspects of the three-phase lesson structure was considered significant, as articulated by Susan, "I think it's the breakdown of the pre-task, explore and summarise." The planner also identified elements of the pedagogy such as questioning and enabling and extending prompts, which were considered critical in supporting teachers to internalise the new pedagogical approach.

> *The summarise [when sharing students' work samples] is the key component that pushes everything together and starts their brains buzzing and we've found a lot of success out of those key mathematical ideas and questions. (Susan)*

A significant change was indicated in the teachers' dispositions towards teaching and learning mathematics:

> *"It's fun! I think because I have been teaching it in a specific way for so long I just got into that routine. It's that whole shift of their ownership and the way we think about tasks and how to make each individual task fun for both them and me. (Susan)*

This clearly indicates a shift in Susan's pedagogy towards student-centred learning. The teachers also identified a shift in student disposition to learning:

> *They are willing to give something a go or to show their work and be wrong. Their ability to try has really shifted. (Susan)*

> *I've noticed that between literacy and maths, they are more willing to share what they are doing in maths. I know we highlight and build them up as we're going but especially some of the students we perceive as being lower are happy to share their answers – it brings them a lot of confidence. (Susan)*

A quote by Susan suggests that her disposition, in particular her perception of the teaching and learning of mathematics, shifted:

> *I think I would like to embed the idea of not always getting it... one idea as a focus for me and for the parents as well so that when their child comes home and says they didn't get the maths that they have got the language to use with them as well.*

An initial challenge, which later became a success, was communication with parents in relation to the pedagogical approaches of the project and the open-ended nature of the tasks. Through this experience these Foundation teachers formed a partnership with parents. The following quotes reflect these realisations.

> *At the beginning of remote learning we did not have the structure in place for the parents to support the children. We learnt that our instructions for teaching the lesson had to be for the parents. We sent an email to parents explaining the EMC3 project and the approaches to teaching... and communicated our expected learning for each task. (Susan)*

> *We realise that it is important to communicate regularly to parents and involve them in their children's mathematics learning. (Jessie)*

Discussion and Concluding Thoughts

Our study sought to capture two Foundation teachers' efforts to implement an innovative pedagogical approach during remote learning. The findings show that these teachers were enthusiastic about exploring a new approach, but their lack of anticipation of the complexity associated with doing so in a remote

learning context provided some initial confusion. Providing time for the teachers to reflect on aspects of the initial remote learning experiences that were problematic assisted them to explore other approaches. These setbacks were the catalyst for exploring synchronous learning with small groups of students, and adapting the proposed lesson structure in the second block of remote learning. These teachers' experiences align with those reported by others, in particular, the difficulty of adapting instructional practice to online learning, and maintaining the relationships with the students (Burke & Dempsey, 2020; Ferri et al., 2020; Kim & Asbury, 2020; Yusouf & Ahmad, 2020).

Three issues apparent from these teachers' initial online experiences resonate with other studies. First, that the student voice within the learning was missing, they lacked the opportunity to engage with their peers and share their thinking (e.g., Kalogeropoulos et al., 2021). Other research reported that providing students with opportunities to explain their thinking and learn from others are critical aspects of the learning environment that supports students' mathematics learning (e. g., Kaur et al. 2013; Pecjak et al. 2021; Yackel & Cobb, 1996). Second, the parents were expected to support their child's learning without any knowledge about the approach, in particular allowing children to engage in productive struggle (Russo et al., 2021) and holding back from telling (Roche & Clarke, 2014). Underpinning these two factors is a need for students to maintain their independence – an essential component of their cognitive development (Hwang & Hariyanti, 2020). Third, the lack of material resources for students to use to support their learning rather than online resources (Ferri et al., 2020).

Unlike the findings of earlier studies that reported Foundation teachers' perception challenging tasks were not for all students (e.g., Russo et al., 2019), Susan and Jessie embraced the opportunity to adapt the tasks for all learners and maintain the challenge. They also saw the need to do this in a remote learning context as well. A key learning for these two teachers from this remote learning experience was the need to go slower and deeper with the tasks and allow time for students to share their thinking. Another learning was the realisation that parent communication was essential, particularly about the innovative approach and the nature of the tasks. This realisation became a driver for these teachers to strengthen their partnership with parents and involve them in their child's mathematics learning during remote learning two.

In addition, remote teaching experiences highlighted key aspects of both teachers' pedagogical approaches that were not as obvious prior to COVID-19, specifically the importance of discussion, student interaction with peers, planning questioning and use of student work samples to stimulate thinking. However, making these adjustments to the way they approached their mathematics planning and teaching did not happen without dedication and focused effort. The teachers' willingness to embrace the challenge, recognise themselves as learners and immerse themselves in the "zone of confusion" (Clarke et al., 2014, p. 9) was pivotal to transforming their pedagogy. Moreover, there was evidence that the disposition of teachers filtered through to student learning, with students embracing the challenging nature of the sequences.

The reflections and accounts of Susan and Jessie's experiences during COVID-19 suggest that having to teach remotely was a catalyst for change in their practice. We suggest that through experiencing confusion and struggle these Foundation teachers restructured their existing knowledge base to accommodate new information revealed through the adverse event of the first remote learning experience. As Lindley (2004) argued, those who do so are in a position to achieve a higher level of personal functioning than if they had never encountered the adverse event in the first instance. Consequently, our study lends further support for the organismic valuing theory of growth (Joseph & Linley, 2005).

In summary, there is little research relating to Foundation teachers' experiences during the pandemic. The findings of this study relating to the experiences and struggles of these two teachers adds to the research literature and highlights two implications for the designers of professional learning and future research. First, to convey to teachers that just as we expect students to struggle when engaging with challenging tasks, teachers may also experience times of confusion, uncertainly or 'not knowing' as they explore new pedagogical approaches. It was only through experiencing the struggle that these teachers realised the importance of the whole class discussions in the Summarise phase of the lesson, and the need to slow down and go deeper. Second, the support of a 'knowledgeable other' is critical, particularly in the early stages of implementation of new learning, as is collaboration, professional dialogue and reassurance that you will not perfect all aspects on your first attempt. Providing such support and collaboration reflects the third recommendation of the Gonski et al. (2018) report stating that Australian education should, "Create the conditions and culture to enable and encourage more professional collaboration, observation, feedback and mentoring amongst teachers" (p. 3). It is through immersion in an encouraging, cooperative, yet ambitious learning community that teachers, like students, will experience the transition from 'confusion to clarity' as they engage with new pedagogies.

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Investigating the Impact of Activities Based on Scientific Process Skills on 4th Grade Students' Problem-Solving Skills*

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Abstract

The purpose of this research is to examine the impact of activities based on scientific process skills on problem-solving skills of 4th grade students in science lessons. In the study a non-equivalent control group pre-test and post-test design type of quasi-experimental method was used. The research study group was composed of 30 students with 15 each in the experimental study group and control group. In the experimental and control groups, for scientific process skills, the "Scientific Process Skills Test (SPS)",and for problem-solving skills, the "Problem Solving Inventory for Children at Elementary Education Level (PSIC)" were used as pre-test and post-tests. Activities including scientific process skills in the experimental group were applied for 8 weeks and 16 lesson hours, while no intervention was made to the control group. In the data analysis process, the Mann-Whitney U test and Wilcoxon Signed-Rank test were used. According to the data obtained from the research, it was observed that there was a significant difference in the post-test scores in the Scientific Process Skills Test (SPST) and the Problem-Solving Inventory for Children (PSIC) of the students in the experimental group compared to the students in the control group. According to these findings, it can be stated that activities including scientific process skills develop problem-solving skills of students in primary science education.

Keywords:

Scientific Process Skills, Science Lesson, Problem Solving, Elementary School Students.

Introduction

In daily life, humankind is faced with various problems all the time. Humans have to think of ways to solve these problems (Fredics, 2003). Individuals try to find solutions to problems they are confronted with at various times. In rapidly changing communities, in order to solve and eliminate problems, there is a need to improve scientific process skills (NSTA, published in 1971, Padilla, Okey & Garrard, 1984). Hence, acquiring scientific process skills and developing them is not unique to scientists (Carin & Bass, 2001; Rillero, 1998).

Scientific process skills include skills which a person can use in all stages of his daily life to become science literate and

to improve his life quality by internalizing the nature of science (Bağcı-Kılıç, 2003; Harlen, 1999; Rillero, 1998; Tifi, Natale & Antonnietta, 2006). Individuals ask questions, they make observations and measurements, they gather data, they interpret data, they collect and predict the probable impact of variables, they make a hypothesis and test it, they obtain test results and they use scientific processes during the process of gaining access to information (Opara, 2011; Renner & Marek, 1990).

In addition to gaining access to information, individuals having scientific process skills can become good citizens who inquire about technological developments around them (Rubin & Norman, 1992).

Scientific process skills (SPS) play a key role in the development of skills such as communication and evaluation and provide opportunities to students to solve problems, to take decisions and to think in a critical way (Harlen, 1999; Myers, 2006; Pekmez, 2000). Competency in these skills enables students to produce new information and to find solutions to problems (Burns, Okey & Wise, 1985). It is expected that individuals who have gained these skills at a significant level will use them to solve problems they are faced with in daily life and to solve problems related with science (Aldridge, published in 1991, Smith, 1997, p. 4). While solving a problem, content information and scientific process skills complement each other in the solution process (Rillero, 1998). Scientific process skills are effective in learning content information because students are motivated to learn, they gain access to information with their own experiences and this is important for them to remember the information (Myers, 2006). In this process, students who use scientific process skills can create knowledge in a more effective way. Students make observations and measurements related with a case or an event, they collect data, they interpret the data they collect and they make a generalization based on the data collected. This process has a positive impact on the permanence of learning and makes learning become more permanent (Bahadır 2007; Preece & Brotherton, 1997; National Research Council [NRC], 1996; Rehorek, 2004).

The Science curriculum based on scientific process skills (2017) aims for all individuals to become science literate. Some of the objectives of the program are to adopt scientific process skills and a scientific research approach and to find solutions to problems faced in these areas, to take responsibility for problems faced in daily life, and during the problem solution process, to ensure the usage of scientific process skills, information related with sciences and other life skills (Ministry of National Education [MONE], 2017). These skills help students to think logically and ask logical questions, and develop their ability to solve problems they face in daily life (German, 1994). Individuals with good scientific process skills can solve problems they encounter in their daily lives both in a short time and by using an appropriate method (Smith & Scharman, 1999). In the light of these benefits, scientific process skills do not only enable acquisition of research, questioning and problem-solving skills while learning lessons in formal learning, but they also enable individuals to attain skills to solve problems faced in their daily lives. These skills are skills that are also used in daily life besides education life. In addition to many aspects, increasing the permanence of learned content and transferring this content to new and different situations (Tifi et al., 2006) makes it important for individuals to gain scientific process skills.

In studies conducted in relation to scientific process skills, it was concluded that education focused on scientific process skills develops the attitudes of students towards science, science literacy, scientific process skills, academic success, problem solving, reflective thinking, and scientific and creative thinking skills (Aktamış, 2007; Batı, 2010; Brotherton & Preece, 1996; Hızlıok, 2012; Karahan, 2006; Kuhn & Dean, 2005; Kurnaz, 2013; Mutlu, 2012; Suryanti, İbrahim & Lede, 2018; Yıldırım, 2012). In fact, according to the results of a meta-synthesis study including 200 studies related to scientific process skills, as there was only one study examining the relationship between scientific process skills and problem-solving skills and as they were limited in relation to elementary school students, this situation constitutes one of the reasons why this study was carried out (Yıldırım, Çalık & Özmen, 2016). As there are few studies examining the impact of scientific process skills on problem-solving skills of students and as studies conducted at elementary school level are limited, this can be said to constitute a deficient aspect of the literature. In the literature, there are opinions stating that the individual attaining scientific process skills can be successful in solving problems he faces in daily life. In this study that was conducted the aim was to examine the impact of activities focused on scientific process skills on problem-solving skills. For this reason, this research was carried out in a science course based on scientific process skills.

Aim of the Study

The aim of this study is to examine the effects of activities including scientific process skills on students' problem-solving skills in the Primary School Science course. In this context, the study sought answers to the following questions:

1. Is there a significant difference in the pre-test scores and post-test scores of the students in the experimental group to which the activities including science process skills were applied?

2. Is there a significant difference in the pre-test and post-test scores of the students in the control group obtained from the SPST?

3. Is there a significant difference between the post-test scores of the students in the experimental group and the control group, which they obtained from the SPST, after the SPS-focused activities were applied to the experimental group students?

4. Is there a significant difference between the pre-test scores and post-test scores of the students in the experimental group, in which activities involving scientific process skills were applied, obtained from the Problem Solving Inventory for Children (PSIC)?

5. Is there a significant difference between the post-test scores of the students in the experimental and control groups obtained from the PSIC, after SPS-focused activities were applied to the experimental group students?

Method

Research Model

The pre-test and post-test control group design type of quasi-experimental method was used in this study, which was conducted to examine the effect of activities focused on scientific process skills on the problem-solving skills of primary school 4th grade students. Since the experimental and control groups were selected from the classes in the school, the quasi-experimental design was used. In this design, the experimental group and the control group were selected without random assignment. The experimental and control groups are pre-tested and post-tested. The experimental procedure was done only in the experimental group. Pre-tests allow the similarity between groups to be known before the application (Büyüköztürk et al., 2012; Creswell, 2013; Fraenkel & Wallen, 2003; Karasar, 2006). The independent variable in the research was activities focused on scientific process skills while the dependent variable was problem-solving skills. In the study, before determining the effect of the independent variable, the SPST and PSIC were applied to the experimental group and control group students as pre-tests. It was determined whether there was a significant difference between the scores. Activities focused on scientific process skills were applied in the experimental group, and there was no intervention to the students in the control group during this process. At the end of the application in both groups, the SPST and PSIC were applied as a post-test and it was examined whether there was a significant difference between the results.

Study Group

The study group of the research consists of 30 fourth grade students studying at an elementary school in the fall semester of the 2017-2018 academic year. The distribution of the experimental and control group students by gender is presented in Table 1 below.

Table 1.
Distribution of Control and Experimental Group Students as per Gender

Group	Gender	*N*	Total
Experimental	Female	8	15
	Male	7	
Control	Female	8	15
	Male	7	

Before the application, teachers working in the 4th grade in a primary school in the city center were interviewed and a volunteer teacher's branch was determined in the studies to be carried out in the experimental group. After the experimental group was determined, a class equivalent to the group was determined as the control group. The scientific process skills pre-test results of the groups are also included in the Table 2.

SPST Pre-Test Scores of Students in Experimental and Control Groups

The difference between the experimental group and control group students' SPST pre-test scores was analyzed with the Mann-Whitney U test and the results are presented in Table 2.

Table 2.
SPST Pre-Test Scores of Students in Experimental and Control Groups

Group	*N*	Mean rank	Rank sum	*U*	*p*
Experimental	15	13.27	199	79	0.163
Control	15	17.73	266		

According to the SPST pre-test results in Table 2, it was found that there was no significant difference between the SPST scores of the students in the experimental and control groups ($U = 79$, $p > 0.05$). According to this finding, it can be said that the scientific process skills of the groups were equivalent.

Data Collection Tools

In the study, the "Scientific Process Skills Test (SPST)"and "Problem Solving Inventory for Children (PSIC)" were used as data collection tools for the purpose of the research. The necessary permission was obtained from the relevant researchers in order to use the data collection tools in the study. As pre-test and post-test to measure scientific process skills in the experimental and control groups the "Scientific Process Skills Test" prepared by Kurnaz (2013) was used. The internal consistency coefficient of the SPST was found to be 0.82 (Kurnaz, 2013). Since the activities involving scientific process skills and the skills in the SPST coincide, the SPST scale developed by Kurnaz (2013) was used as a measurement tool. The skills included in the questions in the scale are presented in Table 2.

Table 3.
Distribution of Questions in SPST as per Scientific Process Skills Dimension

Scientific scale skills dimension	Question number
Making observations	3, 4, 5, 6, 18, 25, 27, 31, 36 and 38
Classification and ranking	1, 2, 11, 17, 28, 29 and 32
Measurement	13, 14, 15 and 22
Making predictions	20 and 30
Establishing a hypothesis	19, 21, 23 and 35
Experiment planning and execution	8, 9, 10, 16, 24, 33, 34, 37 and 39
Interpretation of results	26
Explaining results	7 and 12

In order to measure the problem-solving skills in the experimental and control groups, the "Problem Solving Inventory for Children (PSIC)" developed by Serin et al. (2010) was used as a pre-test and a post-test. According to the factor analysis, 24-itemed measurement tool that consists of three factors (self confidence related to problem solving skill, self-control, avoidance). The Cronbach Alpha reliability coefficient was found to be 0.80 (Serin et al., 2010).

Data Collection Process

There are two basic approaches in teaching scientific process skills. The first of these approaches is the acquisition of scientific process skills simultaneously with the teaching of concepts within the scope of any subject in a given course. Studies show that this approach contributes to acquisition of skills; however, it is emphasized that it has limiting aspects. The most important of these limitations is that the context becomes more intense in the acquisition of skills (Lawson, 1995; Reif, 1991). The second approach to teaching skills is to prepare programs based on the thinking styles of scientific process skills. In these kinds of programs, the course of the subject progresses in an order depending on the scientific process skills. According to the results of research studies, such programs have a positive effect on the scientific processes (Carin & Bass, 2001). In this study, it was intended to carry out instruction that was separate from the context; however, since the preparation of such teaching activities requires experience and a lot of accumulated knowledge, the context was adhered to. For this reason, in the science course, an attempt was made to foster skills in parallel with the teaching of the acquisitions in the "Getting to Know Matter" unit. In the preparation of the lesson plans, the acquisitions belonging to the unit of "Getting to Know Matter" in the Science Curriculum (MONA, 2017) were associated with the scientific process skills they contain and determined by obtaining expert opinion. In the control group, however, the process was carried out by following the science textbook. In the observations made in the control group, it was observed that the teacher taught the lesson with the presentation method of teaching strategy using the training platform.

Designing SPS Activities

The source of scientific process skills is based on the constructivist approach (Padilla, 1990; Roth, cited in 1989, Roth, 1993, p. 128). Many studies have found a positive relationship between scientific process skills and Piaget's developmental stages (Brotherton & Preece, 1995; Chiappetta, 1976; Padilla, Okey, & Dillashaw, 1983; Tobin & Capie, 1982). While designing the activities related with scientific process skills by considering the studies conducted, the age levels of the students were considered and they were planned within the framework of the constructivist approach. While creating classroom activities, the principles of learning by discovery were taken into account. The lesson plans prepared by the researcher and including the SPS teaching activities were put into practice after obtaining expert opinion. Lesson plans were shared with the experimental group teacher, and it was ensured that the lessons were carried out within the plan. In order to get used to the researcher's presence in the classroom, the researcher was present in the science course for 3 weeks before the application. The researcher took part in the class as an observer. The application took 8 weeks and 16 lesson hours with the pre-test and post-test. An example of two achievements is presented in Table 3.

In Table 4, activities prepared for some learning objectives in the Getting to Know Matter unit are presented. In parallel with the teaching of the outcomes, the focus of the activities is on the teaching of scientific process skills. For example, in the "Market Place" activity prepared to improve the measurement skills of students, a small market counter was set up in the classroom, enabling students to measure the mass and volume of different substances.

Analysis of Data

In order to determine whether the activities focused on scientific process skills were effective on students' problem-solving skills, the SPST and PSIC pre-test and post-test scores of the groups were used. The data were analyzed using the analysis program. To see whether there was a significant difference between the scores of the experimental and control groups, analysis was made with the Mann-Whitney U test. The Mann-Whitney U test is the equivalent of the independent t-test in nonparametric statistics (Ekiz, 2015). This test is used to compare data obtained from two independent sample groups (Çepni, 2014). The difference between the pre-test and post-test scores of the experimental and control groups was analyzed using the Wilcoxon Signed-Ranktest. The Wilcoxon

Signed-Rank test is used to examine whether there is a significant difference in the post-tests and pre-tests when the number of two sample groups is less than 30 (Sümbüloğlu & Sümbüloğlu, 2010).

Findings

In this section, the findings related with the objectives and sub-objectives of the research are presented.

SPST Pre-Test and Post-Test Scores of Experimental Group

The difference between the SPST pre-test and post-test scores of the experimental group students was analyzed with the Wilcoxon Signed-Rank test and the results are presented in Table 6.

Looking at the results in Table 5, a significant difference was found between the pre-test and post-test scores of the experimental group (z = 3.42; p < 0.05). Considering the sum of the difference scores and the mean rank, it is seen that this difference is in favor of the post-test scores. The experimental group pre-test-post-test SPST effect size value was calculated as 0.88. The eta square ranges between 0 and 1, and as it approaches 1, the effect size increases (Can, 2016). It is seen that the effect size is large according to the value obtained as a result of the calculation. Based on this finding, it can be said that the activities based on SPS improved students' scientific process skills.

Control Group SPST Pre-Test and Post-Test Scores

The difference between the SPS pre-test and post-test scores of the control group students was analyzed with the Wilcoxon Signed-Rank test and the results are presented in Table 6.

According to the results in Table 6, it is seen that there is a significant difference between the pre-test and post-test scores of the control group (z = 3.309, p <0.05). It is seen that the difference is in favor of the post-test scores according to the sum of the difference scores and the mean rank. This situation shows that the post-test scores of the control group students increased. The control group pre-test-post-test SPST effect size value was calculated as 0.85. It is seen that the effect size is large according to the value obtained as a result of the calculation.

Within the scope of the research, a significant difference was found in the SPST pre-test and post-test scores of both the experimental group students and the control group students. In this case, it can be said that both the program in the experimental group, in which the activities focused on scientific process skills were carried out and the program in the control

Table 4.
Learning Objectives and SPS Activities

Objectives	Activities	Scientific process skills contained in the activities
Compares by measuring the mass and volume of different substances.	Shopping time	Making observations, making predictions, establishing a hypothesis, interpretation of results, explaining results
Defines the substance using its measurable properties.	Market place	Measurement, experiment planning and execution, making predictions, establishing a hypothesis, interpreting results, explaining results
	Covered particulars	Making observations, establishing a hypothesis, making predictions, experiment planning and execution, interpreting results, explaining results

Table 5.
Pre-Test and Post-Test Scores Obtained by Students in Experimental Group from SPST

Pre-test and post-test	*N*	Mean rank	Rank sum	*z*	*p*	η^2
Negative ranks	0	0	0	-3.42	0.001	0.88
Positive ranks	15	8	120			
No difference	0					

Table 6.
SPST Pre-Test and Post-Test Scores of Students in Control Group

Pre-test and post-test	*N*	Mean rank	Rank sum	*z*	*p*	η^2
Negative ranks	0	0	0	3.309	0.001	0.85
Positive ranks	14	7.5	105			
No difference 1	1					

group, where the current application was carried out, improved the scientific process skills of the students. Based on these results, the post-test scores of the groups were compared in order to determine whether the activities applied in the experimental group were more effective than the current instruction given in the control group. The relevant results are presented in Table 7

Experimental and Control Group SPST Post-Test Scores

The difference between the SPST post-test scores of the students in the control and experimental groups was analyzed with the Mann-Whitney U test and the results are presented in Table 7.

Looking at the results in Table 7, it is seen that there is a significant difference in the post-test scores of the experimental and control groups ($U = 45.5$, $p < 0.05$). According to this finding, the experimental group students achieved more success in the post-test than the students in the control group. Based on these findings, it can be said that the activities focused on scientific process skills were effective in the experimental group. The post-test SPST effect size value in the experimental and control groups was calculated as 0.52. According to the value obtained as a result of the calculation, it is seen that the effect size is medium.

Experimental Group PSIC Pre-Test and Post-Test Scores

The difference between the PSIC pre-test and post-test scores of the experimental group students was analyzed with the Wilcoxon Signed-Rank test, and the results are presented in Table 8.

Considering the results in Table 8, a significant difference was found between the pre-test and post-test scores of the experimental group ($z = 3.32$, $p < 0.05$). According to this finding, it can be said that the activities including scientific process skills improved students' problem-solving skills. The experimental group pre-test-post-test PSIC effect size value was calculated as 0.86. It is seen that the effect size is large according to the value obtained as a result of the calculation.

Experimental and Control Group PSIC Post-Test Scores

The difference between the post-test scores of the students in the experimental and control groups was analyzed with the Mann-Whitney U test and the results are presented in Table 9.

Looking at the results in Table 9, it is seen that there is a significant difference between the post-test scores of the control and experimental groups ($U = 62.5$, $p < 0.05$). Considering the results of the U Test, the experimental group was more successful in the post-test than the control group. The experimental and control groups' post-test PSIC effect size value was calculated as 0.38. It is seen that the effect size is small according to the value obtained as a result of the calculation. According to these findings, it can be said that the activities focused on scientific process skills also had an effect on improving students' problem-solving skills.

Discussion

In this study, it was examined whether the application of activities focused on scientific process skills in primary school science education had an effect on problem-solving skills. In this section, an attempt has

Table 7.
SPST Final Test Scores of Students in Experimental and Control Groups

Group	*N*	Mean rank	Rank sum	*U*	*p*	η^2
Experimental	15	19.97	299.5	45.5	0.005	0.52
Control	15	11.03	165.5			

Table 8.
PSIC Pre-Test and Post-Test Scores of Students in Experimental Group

Pre-test and post-test	*N*	Mean rank	Rank sum	*z*	*p*	η^2
Negative ranks	1	1.5	1.5	3.32	0.001	0.86
Positive ranks	14	8.46	118.5			
No difference	0					

Table 9.
PSIC Post-Test Scores of Students in Experimental and Control Groups

Group	*N*	Mean rank	Rank sum	*U*	*p*	η^2
Experimental	15	18.83	282.5	62.5	0.038	0.38
Control	15	12.17	182.5			

been made to associate the conclusions reached on the basis of the findings with the relevant literature (Batı, 2010; Kurnaz; 2016). There was no statistically significant difference between the experimental and control group students' SPST pre-test scores in the findings of the experimental and control group pre-test results. This finding can be interpreted as that the students developed SPS at a similar level with the current curriculum. In other words, it can be said that the current curriculum develops almost the same skills in students. This may be due to the fact that the 2017 Science Curriculum explicitly considers and emphasizes SPS as a learning area (MONA, 2017).

When the findings for the second research question are examined, it is thought that the statistically significant difference between the experimental group students' SPST pre-and post-test scores and the large effect size were due to the effectiveness of SPS-based instruction. In other words, the planning of the activities and the emphasis on SPS dimensions may have caused this difference. This result coincides with the results of studies involving student-centered activities based on SPS (e.g. Aktamış, 2007; Karahan, 2006; Kuhn & Dean, 2005; Kurnaz, 2013).

When the findings for the third research question are examined the fact that there was a statistically significant difference in favor of the post-test in the control group in the pre-test and post-test scores of the SPST and the large effect size may be due to the fact that SPS are taken as a basis in the instruction carried out in accordance with the current curriculum. In other words, teaching SPS by associating them with the subject in both experimental and control groups may have caused this difference to emerge. The acquisition of skills simultaneously with the teaching of concepts in a given course in any subject contributes to the acquisition of skills. However, it is emphasized that it has limiting aspects. The most important of these limitations is that the context becomes more intense in the acquisition of skills (Lawson, 1995; Reif, 1991).

When the findings for the fourth research question are examined a significant difference in the SPST post-test scores of the experimental and control groups and the medium effect size may be due to the effectiveness of the SPS-based activities applied in the experimental group. This result coincides with the results obtained by Aktamış (2007), Kurnaz (2013). In addition to the situations discussed above, it should be noted that a long period of time may be needed for the development of scientific process skills (Tifi et al., 2006). In this study, an attempt was made to foster scientific process skills in parallel with the teaching of the acquisitions in the Getting to Know Matter unit in the science course and the context was adhered to. Therefore, this situation may have led to the development of scientific process skills in students depending on the context (Lawson, 1995; Reif, 1991).

When the findings related with the fifth research question are reviewed, as the PSIC pre-and post-test results of the experimental group were significantly different and as the effect size was big, it can be stated that the activities prepared in accordance with SPS developed the problem-solving skills of students. This finding overlaps with the results of a study that examined the effect of SPS-focused activities on problem-solving skills (Batı, 2010).

Considering the findings for the sixth research question, a statistically significant difference was found in the experimental and control groups 'PSIC post-test scores, while the effect size was small. The fact that the lesson plans planned for the experimental group did not differ greatly from those given in the current books or known activities and the limited time of application may have caused this situation. The reason for the limited time is that the activities are designed as much as the unit time, as the application adheres to the context. In addition, the reason why the activities are known are the skills expected from children in the younger age group; this is due to the fact that they are simple skills such as measuring or classifying (Kuhn, Black, Keselman & Kaplan, 2001). This situation can be considered as a limitation of the study.

Conclusions

The results obtained from the discussion are stated in the items in this section.

1. The fact that there was no significant difference between the experimental and control group students'SPST pre-test scores leads to the conclusion that the current curriculum develops similar SPS in students.

2. The fact that there was a significant difference in favor of the post-test between the SPST pre-test and post-test scores of the experimental group students reveals that the scientific process skill-based instruction is effective.

3. The fact that there was a significant difference in favor of the post-test between the SPST pre-test and post-test scores of the control group students indicates that the current curriculum effectively improves their scientific process skills.

4. The fact that there was a significant difference in the SPST pre-test and post-test scores of the experimental and control group students in favor of the post-test leads to the conclusion that SPS are learned on a context-based basis.

5. The fact that there was a significant difference between the PSIC pre-test and post-test scores of the experimental group students in favor of the post-test leads to the conclusion that SPS-based instruction improves students' problem-solving skills.

6. The presence of a significant difference in the pre-test and post-test scores of the students in the experimental and control groups in favor of the post-test leads to the conclusion that the activities prepared for SPS are not different from those in the current curriculum and known activities.

Suggestions

On the basis of the conclusions reached in the study, the following recommendations can be made:

Suggestions Regarding the Results of the Research

1. Scientific process skills can be taught in two ways. The first one is that only SPS is taught as inherent in the nature of science and the other one is that SPS is taught depending on the subject. In this study, the second type was preferred. In studies to be conducted in the future, activities that are directly focused on SPS can be designed.

2. The ability of teachers and prospective teachers to use scientific process skills effectively can affect the level of students' use of these skills. For this reason, studies can be conducted to ensure that both prospective teachers and teachers participate in activities that will positively affect the development of scientific process skills.

3. The students in the study group of the research consist of 4th grade students. By applying the research to students at different grade levels and age groups, the differences in students' skill levels can be examined.

Suggestions Regarding Studies that Can Be Conducted in the Future

1. Studies on different methods and techniques that can improve students' problem-solving skills can be done.

2. The effectiveness can be investigated by developing activities that make direct associations between problem solving and SPS.

3. The effectiveness of this research carried out in the science course can be investigated by conducting it in different subjects (Turkish, mathematics and social studies) in primary school.

4. Other sub-dimensions of SPS, which are not included in this research, can be included in future studies.

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The Early Bird Gets The Word Games and Play: Creating a Context For Authentic Language Learning

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"The person who knows only one language does not truly know that language."
-Goethe

Abstract

Early foreign language teaching has recently been made compulsory in Finland, making this an area open to development and innovation where policy - makers and teachers play a significant role in creating new kinds of learning environments, operating cultures, and pedagogy for foreign language learning. This article discusses the early foreign language learning landscape in the context of early foreign language learning theory, initial education pedagogy as well as functional foreign language learning. The cornerstone of this study is the Contextual Pedagogical approach to Learning, which creates a bridge between the theory and practice of early foreign language learning, creating an inspiring and stimulating basis for later language learning.

Language is a precondition for learning and thinking. Language is involved in all the activities presented in school and every teacher is a language teacher "(the Finnish National Board of Education 2014, 127). In this article we focus on this idea, presented in the core national curriculum. We attempt to explain the learning environments of language teaching, operational culture, and pedagogical solutions within the theoretical frame of reference of learning another language. The challenges of creating learning environments that support authentic learning experiences, have become still more demanding in today's rapidly changing world.

Keywords:
Early Foreign Language Learning, Functional Language Learning, Learning Environments, Contextual-Pedagogical Approach to Learning

Introduction

"Language is a precondition for learning and thinking. Language is involved in all the activities presented in school and every teacher is a language teacher "(the Finnish National Board of Education 2014, 127). In this article we focus on this idea, presented in the core national curriculum. We attempt to explain the learning environments of language teaching, operational culture, and pedagogic solutions within the theoretical frame of reference of learning another language. The challenges of creating learning

environments that support authentic learning experiences, have become still more demanding in today's rapidly changing world. In the setting of objectives concerning the learning, teaching and evaluation of the languages in the Common European Framework of Reference (See Common European framework of Reference for Languages: Learning, Teaching, Assessment 2001), an aspiration can be seen for even more meaningful learning environments where the starting points for teaching are knowledge, contents, thoughts and feelings, whereas in a traditional language oriented learning environment the main focus has been, and still is, the transmission of linguistic information and in the area of linguistic competence. According to Merisuo-Storm (2002), the study of language learning has changed the concept of knowing a foreign language and as the functional conception of language has gained more ground, the aspects of language learning which are related to the use of language, have become more central to the learning process. Communicative language education has also been created based on this, emphasising the importance of meaningful use of language in language learning. So, learning a language takes place in natural social situations where adopting the language is also strengthened by the fact that studying a language challenges the brain to build new cognitive frames that are based on previous knowledge. This takes time, repetition, consistency, and motivation (Education First 2017). Thus, meaningful contexts that are familiar to the learners and help the brain to connect the language to become part of the authentic operation connected to the pupil's living world have to be utilised in language learning.

Language skills are manifold as a concept. Language skill is the ability to write the texts concerning oneself, to talk on the phone and to manage your affairs in offices. Language skill is to understand and to become understood. Language skill is understanding the structures of language but at the same time accepting the idea of lifelong learning. Language skill is a skill. So, the teaching of language must be based on something other than just internalisation of the language system. Language is interaction and a tool for thinking. (Dufva 2013, 66; Jurkka 2017, 32.)

In this article we examine the various factors in learning a language, and the significance of the functional environments which are specific to pupils learning languages. As we presented in an earlier article (see Piispanen & Meriläinen 2015), games and play are central to early childhood education. Play and games create an authentic environment for learning, interaction, and participation, as well as spontaneous and creative language-oriented activities. This is in line with the curriculum which places and emphasis on the significance of creativity and participation in the learning process (the Finnish National Board of Education, 2014, 27)

In learning languages there is a lot of room for joy, playfulness, and creativity, which can be brought to the learning through play. This adds to the participants' enthusiasm, commitment, and ownership of learning. Play allows pupils to participate in the planning and realisation of one's activity, which in turn serves as a central source of the fundamentally important motivation for learning. In fact, learning and the subjects can go unnoticed by the pupils when they become involved in the process of play. (Marandos & Randall 2012, 541).

It is noteworthy that play and games as part of learning are not restricted to children learning languages. Language experts (Education First 2017) emphasise that authentic situations are also bringing play to adults' language studies: for example, the foreign language cooking courses, dance courses and other hobbies as well as tourism connect language to the playful side of the adults' world. Huizinga (1938), a classic in the pedagogical study on play, stated more than 80 years ago that play was present everywhere and all the time because it is a basic quality of a human being, not only for the children's amusement.

Language In Broadening The World

One of the best-known quotations from the philosopher Wittgenstein is "The limits of my world are the limits of my language." (1984). In his Tractatus, Wittgenstein attempts to deal with the relation of language and reality by stating that the human being can express rationally only what he is able to perceive and can condense to a succinct and unambiguous wording. Here language serves as an intermediary of words and broadens the thinking. According to Wittgenstein, the language fails in describing ambiguous and speculative phenomena satisfactorily despite its aims, for which reason he marks off areas experienced by him as difficult, such as feelings, gestures, values, visions, images, and connotations (the secondary meaning which is created from the association) outside a meaningful human communication. According to the logic of Wittgenstein, the only method of human beings to extend the limits of their world, is to extend their vocabulary and their ability to express themselves. By extending their language skills a human being can describe phenomena that was not perceived earlier -to transmit their thoughts, to communicate and to also find culturally bound significances to the words. (Wittgenstein 1984.)

In the learning context ambiguous and speculative phenomena, such as feelings, gestures, values, visions, images, and connotations, however, help the individual in the building of schemas and in the construction of knowledge. This makes thinking about the context of language learning particularly significant: how to build pedagogically meaningful learning contexts in which the linguistic skills of the learner develop as a

natural part of the development of knowledge and skills? According to Lehtonen and Vaarala (2015), as changes occur in our approaches to learning, there has been a shift in second language learning theories, a move towards more holistic theories: language learning is seen as a process rather than considered to be the final learning outcome. In teaching it is essential to offer opportunities for language use and practise in authentic situations and environments by creating language situations which make communication and interaction possible.

The studies have shown that the integration of language to the teaching of content in different subjects is a more efficient way to learn language compared to the traditional language teaching method in which the language is learned as a separate subject. (Meriläinen 2008; Genesee 1994) According to studies, adopting a foreign language takes place most efficiently when the language is used as a tool for communication in meaningful contexts. In this kind of teaching the pupils participate in real situations of language use and thus learn to use a new language when studying, which also increases the pupils' motivation because only a few young people get excited about language studying when it is abstract and regarded as separate from one's own life.

So, the learning of a language is something more than just adopting the rules of a language. Language is a changing tool with which we interact and take care of business. Language also always expresses the culture, to which it is related. According to Krashen (1985) a learner is most able to take advantage of a language learning situation when the structures of the language presented are only slightly above the learner's skill level. Krashen describes this situation with the diagram i + 1 in which i represents the level of the language skill the learner commands. The ideal input is not only suitably understandable but also interesting and essential for the learner. In addition to the input, it is also important that the learner must experience the language learning situation as positive. The affective filter may prevent or may promote the adopting of linguistic material. In addition, Bergström (1995) noticed in her study that in the learning situation of the foreign language, a safe learning atmosphere is a significant factor. According to her it must be possible for every pupil to use language safely and diversely as a tool for learning so that a new language gradually begins to feel like one's own.

Examination of Language Learning In The Light of Sociolinguistic Theories

The sociolinguistic theories emphasise the significance of the environment in learning a language. In sociolinguistic theories there is a greater significance on the learner's social environment than on the internal action of the individual. The interaction and the use of language in different situations which require communication facilitate the learning of the language, adopting, understanding, and becoming understood. There is high significance here on creating a safe atmosphere and on meeting the pupil. (Lightbown & Spada 2006, 46- 47.)

Leo Vygotsky is one representative of the sociolinguistic theory who specifies the language as an internalised speech which develops through interaction: language is first learned in the interaction with others, and second as an internalised speech of the individual. Vygotsky emphasises the idea of the zone of proximal development which refers to the individual's actual level of development, which stays between their present knowledge and skill level and their possible potential level of development. For the knowledge and skills to still develop, the individual needs guidance and teaching that develops their own level of knowledge and skills. Dufva (2013, 60) condenses the matter so that the skill, which is learned in practice, will be first practised together with the person who already commands the skill and eventually, the learner is able to use the skill independently. Lightbown and Spada (2006, 22) concretize the zone of proximal development by using the development of baby talk as an example: the child will not develop in their language development if they are not guided "to the following level" but instead talked to childishly. (cf. Krashen: input + 1:) A response is not expected from a baby, but the parents should talk to the child as if they could understand and could answer. The expressions and gestures support the dialogue. Interaction is the most important and the baby needs to be encouraged to take part in it? (Jurkka 2017, 25). Jurkka (2017, 25) makes one think where the line is between speech and baby talk. Correspondingly, as good a result is not achieved by merely listening to the TV or radio compared with genuine interaction. Language can develop through repetition, questions, and verification of answers. A mere repeating of the language does not talk about skills and understanding.

Identification and definition of the level of language skills to be aimed at, and planning and implementing the methods of language teaching so that the language skills increase and develop systematically is indeed one central dimension of functional language teaching. The awareness of what type and which level (cf. Common European framework of Reference for Languages) of language skills are aimed at in the teaching, essentially directs the planning of the teaching and the choice of the teaching methods which make the development of versatile language skills possible.

Larsen-Freeman (1997; 2007) creates the bridge between the scientific chaos theory of Isaac Newton and the development of language. According to

her, language should be seen as a wholeness of the complex and non-linear systems, where the evaluation of its separate parts cannot provide a real picture of the whole. It is as if the continuously changing language is in chaos for the learner of the language all the time: the parts of the language change their form, sometimes strengthening and sometimes weakening, and to learn the language is sometimes slow and sometimes fast. Learning a language is not linear but proceeds at its own pace and own ways for every learner. (1997, 141-142; 2007, 780-783.) Language is a dynamic tool which constantly changes and through which thoughts are expressed in writing or orally - it is a communication system, where the code changes all the time.

Language is a communal skill, which is why, when we create language learning contexts, they should be authentic interaction contexts, in other words, real or imitating reality. In these contexts, language has a real significance and becoming understood, and understanding are real starting points for the development of functional and communicative language. (Järvinen 2014, 83-85; Dufva 2013, 63.) Discussion at a reception, asking the way, ordering food, and attempting to play together are examples of real-life social situations. In sociolinguistic theory, the importance of imitating the group is emphasised. Such collaborative learning where every learner brings their own knowledge and skills to the situation and the shared knowledge of the group develops together, changes the knowledge of an individual into something owned (Jurkka 2017, 25).

Play as Part of Learning In Supporting Language Learning

A well-planned game, whether it is based on free or scripted interaction, provides positive and efficient opportunities for learning a language (Godwin-Jones 2013.) Studies have shown that using the language to be learned increases (Peterson 2010) because to proceed in a game or in play tasks the learner must use the language: one must understand and possibly engage in the oral or written interaction with the elements of the game or with the other players. When one is interacting with others, the socially (pragmatically) correct use of the language is more important than grammatical correctness. This supports the development of the communicative competence of the learner. (Rama et al. 2012.)

Play is one of the most natural, most important, and most meaningful functions and learning environments in the child's life. Play is the child's communication tool. In play children can also express themselves without words. (Stagnitti 2010, 372.) When the words become part of the play, the effect of play and words which support each other strengthens the language, creates, and tests values and rules as well as develops operation in the social situations (cf. Huizinga, 1938). Huizinga (1938) even states that play is one of the most important sources of pleasure and creativity experiences (cf. flow –state:) the one who gets absorbed in play easily forgets the time and the environment and experiences being part of the events of play. However, a pedagogically well-planned play is extremely important in learning and a starting point to be generalised as the foundation of learning at every age. (Piispanen & Meriläinen 2015)

As in all the educational solutions, the starting point for the use of games is objectives: what is sought to be achieved through the play and games, which skills are practised, what are the learner's needs and wishes for the activity and for learning itself. The success in using games depends on how well the game answers the objectives set, and how the game is used as part of the teaching or to support it (Godwin-Jones 2013.) It is not a coincidence that games, playing and game-like solutions are also of interest and are topical as an area in language learning and as an area of research because games reflect a pedagogical change in language learning more generally (Cornille et al. 2012.)

From a learning environment point of view play as part of learning means varied learning in the play and games environments. Play has many forms: it can be play or a game which contains rules, or a free activity which contains a state of imagination and creativity, and in which the player practises a social and cognitive spontaneity in the shared activity, in the jointly agreed environment.

Emotions play an important role in learning. Games and play give room to feelings because they allow the taking of roles. New and even difficult matters for the child can be approached through play – playing creates a safe environment because the character of the jointly agreed play includes the understanding of the play specifically as play, and the understanding of the role, inside the play, specifically as a role (Piispanen & Meriläinen 2015). The tension related to the activity diminishes through the play and on the other hand a strong sense of commitment is connected to play. Informal knowledge is processed through play and play can be a bridge between formal, non-formal and informal learning.

Creative and communal learning takes place through play. Play as part of learning connects cognitive, emotional, and bodily operations. Play as part of learning is at its best the joy of achievement and success. (Kangas 2014, 74-78; 83; 85-86.) According to the studies (among others, Järvinen 2014, 72) feelings of anxiety are often linked to learning a language, which for its part makes learning more difficult. Play as part of learning has instead been often noted to reduce anxiety towards participation and thus facilitates practice in the use of the language (Hakkarainen

2004, 384 etc.). Safety at the emotional level gives the players an opportunity to experience disappointment and vulnerability and allows room for mistakes to be made.

When playing, a child learns because of their own operation, which is a significant factor regarding learning new things and constructing knowledge. According to Hakkarainen (2004, 160) the player becomes absorbed comprehensively in the play and does not analyse why they play, which for its part reduces anxiety that the pupil may experience when facing learning new things. Playing together is pleasing for the child and play provides positive feelings which promote and maintain motivation.

In the frame of reference of language learning, a good play or game - learning environment with play and games as part of learning -is based on the foundation of the socio-constructivist learning theory. Learning takes place through active participation and interaction as we form our increasing understanding with the help of shared knowledge and skills. In social play, a child verbalizes their operation which is central from the learning point of view: a child verbalizes their operation and reflects on what they learn together with the other children (see Vygotsky 1982). According to Lerkkanen (2006, 43) and Dewey (1957, 76; 143) the pupils commit themselves in the tasks which they regard as meaningful to themselves. Play and games that pay attention to the learner's stage in life and to their subjects of interest are important factors here. The pupil gets excited in the task and believes that they can manage the activity through intrinsic motivation. When encouraged by external motivation, the pupil becomes interested in completing the task only because of a goal to be reached. At school, both motivations are needed but only with intrinsic motivation can significant, long time learning results and commitment be reached. (Jurkka 2017, 19.)

According to Koskinen, Kangas and Krokfors (2014, 28-30) the guiding role of the teacher is significant in the play as part of learning -learning process: the teacher plans and organises, guides to a game-like process, supervises during the game and collates what had been learned after the game. According to Jurkka (2017, 20), it is pedagogically significant that the teacher defines the contents of the game, in other words, what is learned through the game. In a small group game, the pupils can practise social skills and collective thinking. Piispanen and Meriläinen (2015, 230) state in their study on playing as part of learning, that the teachers' role is important particularly as pedagogical planners of learning projects in which case the objectives and contents of the curriculum create those tasks and contexts in which the play is performed: *As regards learning, both context and pedagogy are seen as being linked to interaction between an individual and his environment. Thus, learning is a personal experience that happens in interaction with the environment. It is not restricted to learning a single fact but aims at logical thinking through a diverse dialogue with the environment, and with the help of reflection, reasoning, and research. (Meriläinen & Piispanen 2012, 2019.)*

The starting point is not to learn the content of any subject, even with regards to the curriculum, but to help the pupil to understand that in fact the content becomes meaningful when they are connected to a context. Functional language studying springs from the frame of reference of authentic learning, where the language, instead of being seen as the target of learning, is seen as a tool for learning - the language skills enable genuine interaction and ways to express oneself instead of learning the language separated from its natural contexts.

From the point of view of language learning, the amount of repetition in games and play has an important significance in learning a new language. Repetition of the sounds and words strengthens the discrimination of sounds and gives opportunities to practise the intonation. The children preserve the words and phrases they learn in their memory and use language when they are ready to do so. Therefore, all the opportunities for the safe repetition and use of sounds, syllables and words are good. (Keaveney & Lundberg 2016, 57; 59-60.) Play is an excellent tool in adopting and remembering concepts. It serves as a safe factor with a significant role in handling new and complex situations and in developing motivation. (Hakkarainen 2004, 160-161; Helenius & Korhonen 2011, 71.) In play, "the repeated part" can be for example a song, joining movement to the words, connecting a theme to the language, or rhyming - the recurrence, interaction, and the use of different sensory channels in supporting learning are essential. When learning a new language, innumerable possibilities to listen and to practise pronunciation and intonation are needed. (Keaveney & Lundberg 2016, 57; 59-60.) When examined from these many points of view, the use of play as part of learning and as a tool for language learning supports the sociolinguistic concept of language learning: the interaction and the opportunity for authentic use of language promote the idea that language serves as a tool of one's own expression instead of being just a separate thing to learn. (Järvinen 2014, 79; 83-85; Dufva 2013, 63; Lightbown 2006, 46-47.) Language awareness is not the primary aim in learning a language, something which one should know how to analyse and command. In learning a language, it is rather a question of learning a skill - of becoming understood and having communication skills - of experiencing the possibility. (Education First 2017.)

Development 0f Language Skills In The Frame of Reference of The Core Curriculum

The objective of planning in language teaching is to direct the teacher to think about the learning processes as entities which develop the language skills in a variety of ways. This approach to planning helps to develop teaching which builds language skills systematically with the help of the chosen teaching methods, teaching materials and learning environments. With detailed planning the teacher's task is to define the central aim of each individual learning situation with regards to the development of language skills. In authentic and integrated language teaching this comprises the central objectives and content areas, vocabulary, studying the language structures, the chosen teaching methods, materials, and the study strategies which support learning, as well as evaluation. Planning must encompass the teaching of content, the numerous linguistic aspects which will form the focus of the lesson and will be needed to meet the learning objectives, and any cross-curricular skill development.

In planning an individual lesson, attention is paid to the central vocabulary which is linked to meaningful activities, these in turn create natural and authentic situations to use the language by utilising different sensory channels in a variety of ways. One important aim of teaching is indeed to plan the teaching so that the pupils' language skills will expand over the subject barriers to a cross-curricular level (cf. content compatible language learning) (Meriläinen 2008, Meriläinen & al. 2019). According to Meriläinen (2008), the teacher must take care to ensure at the planning stage that the activities planned provide plenty of opportunity for language use to ensure that the language learning outcomes, as well as content learning outcomes, are met. In addition to that, it is important that the chosen teaching methods direct pupils to study matters diversely in authentic social situations utilising the possibilities of the digital age. Versatile learning environments offer a natural context for the development of language skills.

In the Finnish National Core Curriculum (2014) the following areas of language learning, which direct the planning and implementation of teaching, have been raised as the focus of language teaching: Education into cultural diversity and language awareness, Language study skills, developing language competence: skills in interaction, developing language competence: skills in interpreting texts, and Developing language competence: skills in producing texts. These five areas form the central objectives for language teaching and learning, with the emphasis on teaching. As, a tool, which directs the development of language skills, the teacher uses the chart of developing language skills (formulated from CEFR) as well as the Common European framework of Reference for Languages. With the help of these, the systematic and cross-curricular development of language skills takes place, and it is possible to attain the learning outcomes set out in the curriculum.

The central starting points in this article were play and games as part of learning in the planning of an authentic and functional language learning landscape. A teacher, when planning and implementing early language learning must make sure that language learning environments inspire pupils and make learning possible. Teachers must also be aware of the purpose of the games and play selected for teaching, and how they can be used to achieve learning outcomes.

Planning the teaching using the Curriculum 2014 – as a frame of reference creates the foundation for aim-oriented language studying. The authenticity of teaching, contextuality and versatile opportunities arising from the student's world of experiences for using language, as well as cross-curricular teaching, enable the broad development of language skills. With globalisation, communicative skills of foreign languages have become still more important both in study and in working life. In addition, shifting populations have resulted in an increasingly multicultural society which increases the need for language skills and creates new challenges for language teaching. Games and play as part of learning are part of the child's natural way of operation and offer approaches to the language studies which develop different areas of language diversely. The genuine social situations created through play make language use meaningful and create possibilities for the pupils to practise their language skills in authentic situation, like those which pupils are likely to meet outside the classroom.

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The Effect of Parent-Involved Reading Activities On Primary School Students' Reading Comprehension Skills, Reading Motivation, and Attitudes Towards Reading*

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Abstract

The purpose of this study is to examine the effect of parent-involved reading activities on elementary fourth graders' reading comprehension skills, reading motivation, and attitudes towards reading. Employing a pretest-posttest quasi-experimental design with a paired control group, data were collected from a total of 100 fourth graders studying in two different primary schools. The findings showed that there were significant differences between the experimental group and the control group, meaning that the parent-involved reading activities developed by the researchers had a positive effect on the students' reading comprehension, reading motivation, and attitudes towards reading. This research contributed to previous body of research regarding the impact of family involvement on academic achievement and affective factors. Various suggestions were offered to policymakers, researchers and practitioners.

Keywords:
Parental Involvement, Parent-Involved Reading, Reading Comprehension, Reading Motivation, Attitudes Towards Reading.

Introduction

It is widely accepted that parents have a significant role in their children's education and influence their learning and development (Froiland and Davison 2014; Pinquart, 2015). Many studies have shown that parent involvement is related to children's academic success (McNeal, 2015; Wang and Sheikh-Khalil 2014), their attitudes and motivation towards school or lessons (Frenzel et al. 2010; Lipnevich et al. 2016; Simpkins et al., 2015; Spera, 2006) and desire for education (Jung and Zhang 2016, Leung et al. 2010). Considering that reading comprehension skills acquired in primary school years affect all learning experiences of individuals throughout their lives (Bradley, 2016), it can be argued that family involvement play an important role in the development of primary school students' reading comprehension skills.

The academic achievement of primary school students with improved reading skills is higher than those with poor skills (Epçaçan, 2018). The results obtained from studies that make statistical comparisons about reading comprehension on an international scale, such as the Progress in International Reading Literacy Study (PIRLS) and the Program for International Student Assessment (PISA), in which Turkey also participate, show that, like many countries, Turkish students do not have reading and comprehension skills at a desired level (Aslanoğlu and Kutlu, 2007; Özmusul and Kaya, 2014). Therefore, there is a need for practices to improve reading and comprehension. Reading comprehension, which is the focus of this study and the main purpose of reading in general is closely related to the concepts of motivation, attitude and social environment since it is a mental, psychological and sociological activity (Snow, 2002). Reading is not only related to the individual, but also the environment and family because it combines both physical and mental factors (Ünal, 2006). The social environment, including family members in particular, is a considerably effective factor in the development of reading comprehension skills. Considering this effect, some researchers have drawn attention to the concept of home literacy (Burgess et al., 2002; Hiğde et al., 2020; Senechal and LeFeve, 2002). With home literacy, it is expected that children will grow up in an environment familiar with books, leading to a culture of reading in individuals (Hiğde et al., 2020).

In the literature, valuable results have been obtained in different studies on the effect of parental involvement on reading. For example, parents' listening to their children's reading, reading together, and supporting them have been found to provide significant gains in their literacy, positively affecting variables such as reading speed, accuracy and fluency, as well as contributing to independent reading (Hindin and Paratore, 2007; Neuman and Celano, 2012; Senechal and Young, 2008; Steiner, 2014; Steiner et al., 2022). However, research on the relationship between motivation and attitude, two factors that affect reading comprehension, and parental involvement are relatively limited (Klauda, 2009; Baker, 2003; Senechal and Young, 2008; Loera et al., 2011; Pavalache-Ilie and Tîrdia, 2015; Villiger et al., 2012; Yeo et al., 2014). These studies focused on the impact of family culture, home literacy environment and parental encouragement on preschoolers and students with reading difficulties, and the effect of various reading activities on children's reading achievement, the influence of immigrant parents on children's reading involvement and intrinsic motivation. Villiger et al. (2012) investigated the effect of a home-based intervention program on fourth-grade primary school students' reading comprehension and motivation. Despite the fact that families have a significant capacity to boost reading motivation (McElvany and Artelt, 2009), intervention programs that integrate the family and school environment are rare (Villiger et al., 2012), indicating a research gap in this area. Considering the effect of parental involvement on the development of reading skills, it is important for schools and educators to determine how they can help parents who have difficulties in supporting their children in this regard (Lee and Bowen, 2006).

Although there are findings that point to an increase in student achievement by strengthening the relationship between school and parents, limited attention is given to how this school-parent cooperation or parent participation should be provided and developed. The present study aims to examine the effect of parent involvement through parent-involved reading activities on children's reading comprehension, reading motivation and attitudes towards reading. The research questions that are posed in the study are as follows:

1. What are elementary fourth graders' levels of reading comprehension, reading motivation, and attitudes towards reading before the experimental process?

2. Is there a significant difference between the experimental group in which parent-involved reading activities are applied and the control group in terms of posttest scores in reading comprehension, reading motivation, and attitudes towards reading?

Theoretical Foundations

Although different concepts emerge in the definitions related to reading, the concept of "comprehension" is mentioned in almost all definitions. For reading to have a value and for the realization of high-level mental processes such as interpretation and meaning construction, the act of reading must first result in comprehension. the reading activity has a " comprehension" goal at its core. A reading activity that does not result in comprehension cannot be considered to have achieved its real purpose. Comprehension is possible when the individual comprehends the meaning represented by printed symbols (Luma, 2002). Reading without comprehension is not reading, but merely vocalization (Yılmaz and Köksal, 2008). Akyol (2006) defines reading comprehension as forming a new thought because it involves comparing and synthesizing readers' prior knowledge with what they have learned from texts. In the context of primary school children, it can be concluded that they must encounter rich stimuli to increase their prior knowledge. Children who grow up in such an environment will have more background knowledge and will be more successful in reading comprehension than their peers. Snow (2002) states that the reading comprehension process consists of three basic elements: reader, text and the reading activity. Readers make sense of the text in a complex process involving their cognitive abilities (i.e., attention, memory, analytical thinking, inference, visualization),

motivation (ii., reading motivation, interest in content, self-efficacy), knowledge (i.e., vocabulary, content, grammar and discourse, comprehension strategies) and experience. These characteristics vary considerably among readers and cause differences in reading comprehension levels among individuals (Snow, 2002).

Motivation, the second key concept in the present study, is the force that pushes a person to be involved in any activity (Kreitner, 1995). Guthrie and Wigfield (2000) define reading motivation as individuals' goals, values, and beliefs about the subject, process and reading outcomes. Reading motivation can be quite effective in directing individuals to read and help them comprehend what they read, and therefore more emphasis should be placed on this concept. Motivated readers spend more energy and time in reading than in other activities (Wigfield and Tonks, 2004). This power can be internal (eg interest and curiosity) or external (eg reward, family, friends, school, etc.). (Wigfield and Guthrie, 1997). Students who are intrinsically motivated are more inclined to explore the world of reading, find various topics that interest them, enjoy reading, have difficulty coping with the difficulties they encounter, and improve their reading skills (Hidi, 2000).

Attitudes towards reading, the third key concept of this paper, are individuals' feelings towards reading and determine how often children read (Partin and Hendricks, 2002). To provide the expected personal and social benefits in reading, individuals should love reading and should not avoid it (Akkaya and Özdemir, 2013). Students' attitudes towards reading affect their motivation to reading (McGeown et al., 2015). In this regard, positive attitudes towards reading can also play an important role in time that individuals spend for reading and the strategy they use to comprehend what is read. Accordingly, many studies have shown that positive attitudes towards reading have an impact on reading instruction (Gibbons 2003; Forman et al., 1998; Marshal, 1992; McKenna et al., 1995; McKenna and Kear 1990; Smith, 1992). Consequently, students with positive attitudes tend to be successful readers.

When empirical studies on family involvement are examined, it has been observed that researchers tend to use some theories and models to explain the family-school partnership and frame their studies (Yamauchi et al., 2017). Social Learning Theory, Socio-cultural Learning Theory, Social Capital Theory, Ecological Systems Theory, and Epstein's Parental Involvement Model can be given as examples. Social Learning Theory (Bandura, 1977) considers how both environmental and cognitive factors interact to influence human learning and behavior. The theory focuses on the significance of observing, modeling, and imitating the behaviors of other individuals (Bandura, 1977). In this vein, individuals, especially children, observe many people such as their parents, elder siblings, friends, and teachers around them and might see them as role models. Sociocultural Theory (Vygotsky, 1978) emphasizes the role that social interaction plays in psychological development. He proposes that learning is largely a social process and that our cognitive functions are based on our interactions with the "more gifted" people around us. With the concept of the Zone of Proximal Developmental (ZPD), Vygotsky states that children can generally expand their developmental areas by observing more developed individuals (Vygotsky, 1978). The environment in the family is considered the first and most influential factor for children. This is because parents can monitor their children's potential more closely. Parents also provide valuable assistance to educators on how to develop this potential. Parents form the closest social environment where schools communicate with students and are primarily responsible for their activities outside of school. Therefore, it would be a big mistake for parents not to be involved in the learning process as they are their children's first teachers. Social Capital Theory claims that social relationships are resources that can lead to the development and accumulation of human capital (Bourdieu, 1986). For example, a stable family environment can support educational success. Bronfenbrenner's (1977) Ecological Systems Theory views child development as a complex system of relationships influenced by various levels of the surrounding environment, from family and school settings to broad cultural values, laws, and customs. Thus, to examine a child's development, one must look not only at the child and his immediate environment, but also at the interaction of the wider environment. Bronfenbrenner divided the person's environment into five different systems: microsystem, mesosystem, exosystem, macrosystem and chronosystem (Bronfenbrenner, 1977). The microsystem is the most influential level of the theory. This system includes closest environments such as school and family in which children are involved.

Epstein (1995) developed a framework that describes six different types of parent involvement (See. Figure 1.). The types of family involvement included in his model constitute the most popular framework researchers use to conceptualize the family-school partnership. Epstein argues that schools often have better outcomes when parents are involved because students are influenced by the coherent message that home and school create about the importance of education (Epstein and Sanders, 2000). The theoretical framework of this study was also built on Epstein's six types of parent involvement.

Figure 1.
Epstein's model of six types of parent involvement

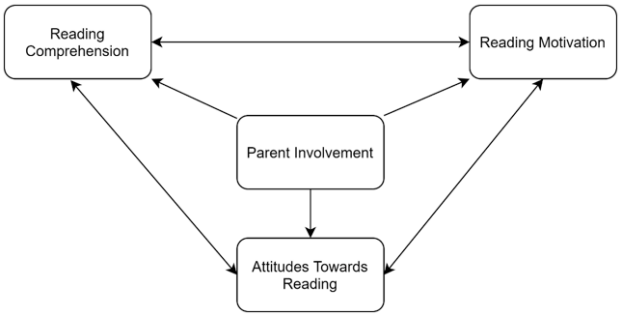
Epstein (2018) states that parent involvement can be provided in six different ways in the parent involvement model, which includes some suggestions to improve school-family cooperation. These include parenting, communication, volunteering, learning at home, decision-making, and collaboration with the community.

The first type of participation is through primary parenting. Basic parenting means meeting the basic needs of parents, including issues related to health, shelter, safety, and nutrition. It also includes all the activities done to help parents support the learning environment at home. The second type of parent involvement is communication that occurs when effective mutual communication is established between school and family about children's education and development. Communication can take various forms such as phone calls, notes and meetings. The third type, volunteering, occurs when parents take time out to help the school system or participate in school activities. Volunteering refers to voluntary families who contribute to the education of their children. It can be in the form of parents coming to school to help students and teachers traditionally. The fourth type of participation, home learning, includes all activities for helping the child with homework or other lesson-related tasks. Parents can talk to their children about school at home, help them with homework, and help them develop necessary skills. The fifth type, decision making, focuses on the representation of parents in the school system and their formal participation in decisions. By taking part in school-parent unions, families can have a say in the policy and management of the school. The last type, cooperation with the community, refers to the cooperation of parents with the school and society to strengthen school programs and contribute to student learning (Epstein, 1995; 2018).

Conceptual Framework

In this study, a conceptual framework was developed based on the theoretical basis outlined above (Figure 2). Reading activities with parental participation were created under the learning-at-home dimension to examine its effect on reading comprehension, reading motivation and attitudes towards reading.

Figure 2.
The conceptual framework of the structural relationship between parent involvement, reading comprehension, reading motivation and attitude towards reading.



Based on theory and research summarized above, parental involvement can be argued to have a strong relationship with reading comprehension, reading motivation and attitude towards reading. By means of this study, it is aimed to provide the literature valuable evidence that parent involvement can have a role in different aspects of reading comprehension skills.

Research Method

In this study, a pretest-posttest quasi-experimental design with a paired control group was used to investigate the effect of parent involvement on reading comprehension, reading motivation and attitudes towards reading. Experimental studies are attempts to test the effect of differences created by the researcher on a dependent variable (Büyüköztürk et al., 2012). Quantitative data obtained through scales in the experimental process contain closed-ended information and are analyzed employing statistical methods (Creswell and Plano Clark, 2011).

The pretest-posttest quasi-experimental design with a paired control group aims to match the groups based on certain variables. No random assignments are done in this design. However, it is a good alternative in cases where random assignment is not possible (Büyüköztürk et al., 2012). A non-significant difference between the groups in the pretest scores is important in terms of equivalence. At the end of the process, the data are compared to see whether there is a significant difference between the experimental and the control group based on the posttest scores (Bulduk, 2003). The model of the experimental design followed in the present study is represented in Figure 3.

The participants in both groups were tested concerning the dependent variable before and after the experimental procedure. The scores obtained from the reading comprehension achievement test, reading attitude scale, and reading motivation scale constituted the dependent variable of the study. The experimental and control groups were formed through pairing after the pretest. Parent-involved reading activities developed by the researchers were regarded as the independent variable. In this context, it was examined whether the independent variable influenced the dependent variables.

Implementation Process

Development of parent-involved reading activities: In the experimental process, parent-involved reading activities were done by the students and their parents. The process in which the reading activities were developed is represented in Figure 4.

Determining the texts: Parent-involved reading activities are a set of materials consisting of reading comprehension activities related to narrative and informative texts. The development of these activities started first by determining the narrative and informative texts suitable for the fourth graders. A pool of 24 texts comprising 12 narrative texts and 12 informative texts, selected from books approved by the Ministry of National Education and suitable for the level of fourth-graders, was created as a result of a review lasting approximately three months.

Receiving expert opinion: An expert opinion form was prepared to determine which texts were suitable for use in the reading activities. The texts were sent to 10 experts, three Turkish language teacher trainers and three primary school teacher trainers working at the Faculty of Education, Muş Alparslan University, Turkey, and four primary school teachers teaching fourth graders. In this form, they were asked to evaluate the

Figure 3.
Pretest-posttest paired control group design.

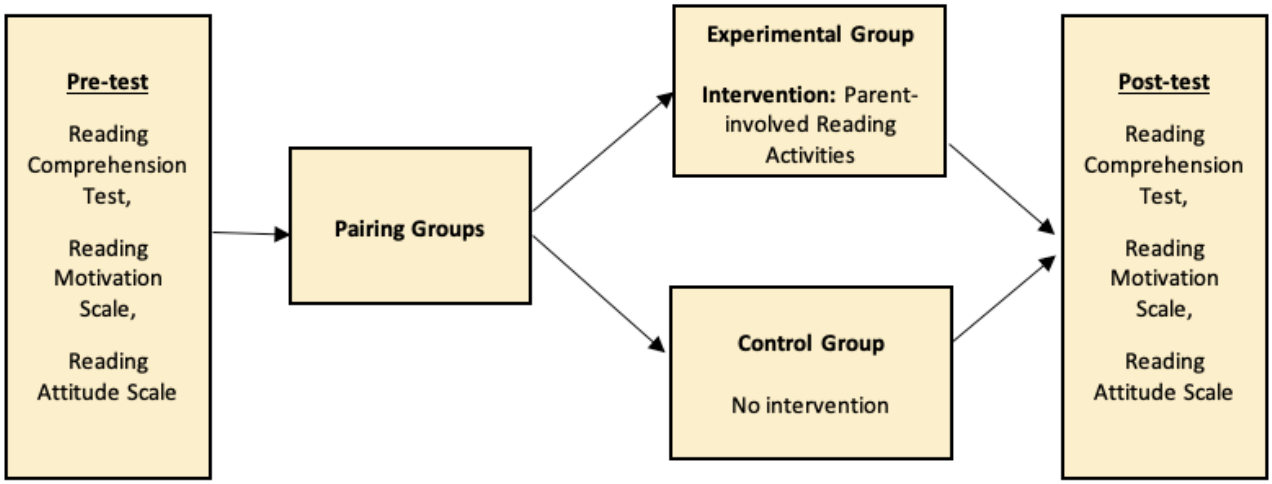
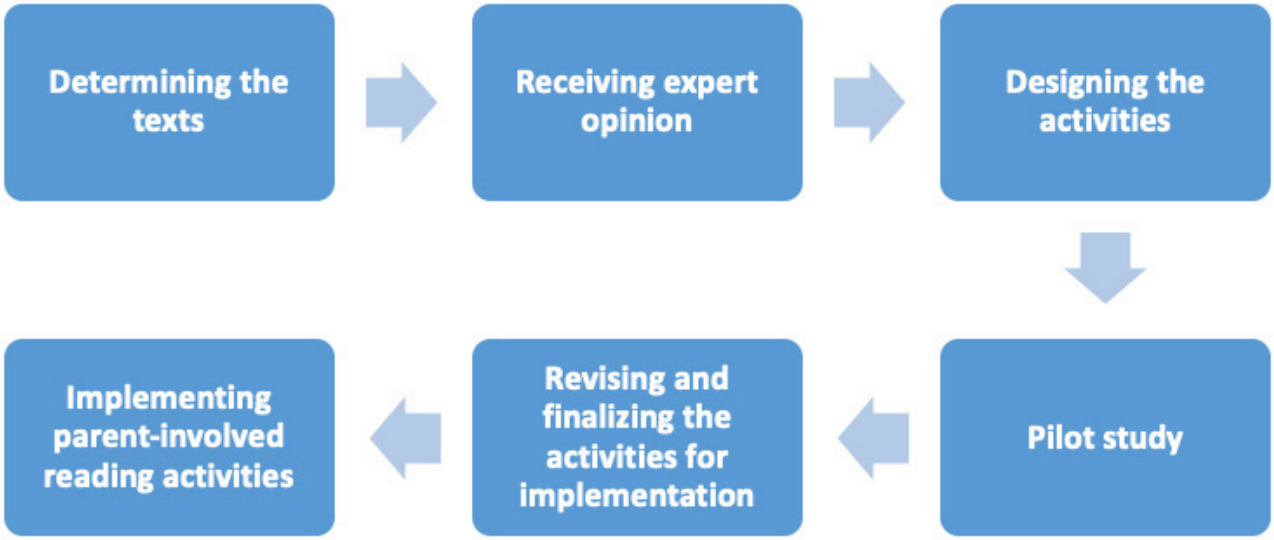


Figure 4.
Process of developing the reading activities



texts as appropriate, somewhat appropriate, and not appropriate, writing additional comments when necessary. As a result of the experts' evaluation, eight texts with the lowest score were eliminated, and the remaining 16 texts were deemed appropriate to be used in the reading activities.

Designing the activities: A wide range of texts and relevant activities are included in coursebooks to equip students with reading comprehension skills as part of the objectives for Turkish language education in Turkey. Akyol (2006) indicated that it is necessary to follow certain steps to reach the meaning in reading, and systematically describes these steps to be taken before, during, and after reading. Therefore, the activities that can be done before reading as scanning, setting goals for reading, recalling the background knowledge to the reading environment, and making guesses were designed in this direction. As for the during-reading activities, reading fluently, checking comprehension, and using helpful strategies can be considered as appropriate for this study. While preparing the reading activities with parent participation in the present study, these steps were taken into consideration, and the activities were categorized as pre-, during- and post-reading activities. Following the determination of the reading texts, the reading comprehension activities for each text were designed by considering the reading comprehension outcomes set in the Turkish language course curriculum. Expert opinion was also received concerning the designed activities. The experts were two Turkish language teacher trainers and three primary school teacher trainers. The activities were organized in line with the feedback received from the experts and were finalized for use in practice.

Pilot study: Before proceeding with the implementation, pilot sessions including three weeks of the reading activities with parent involvement were conducted with four parents.

Revising and finalizing the activities for implementation: The activities were revised based on the feedback received from two Turkish language teacher trainers and finalized for implementation.

Implementing parent-involved reading activities: Before the implementation process, training in which the activities were developed by the researchers was given to the parents. The parents who attended the training were informed about their children's performance and how to implement the reading activities at home and provided with a guide brochure. The training was held in two sessions for a total of six hours. It consisted of 16 activities, eight of which are related to narrative texts and the remaining about informative texts. These activities (i.e., two activities a week; a narrative and an informative text and relevant activities) were given to the experimental group students every Monday, and the ones that had been completed were gathered the same day of the following week. At the end of each activity, parents were asked to sign the pack and write their opinions and thoughts about the activities to monitor whether the tasks were implemented. The process started with 50 parents and their children, and the activity packs were examined weekly, the mistakes made in the activities were noted and shared with the parents by the researchers. A file was kept for the activities of each student, home visits were conducted, and the general evaluation of all activities was done with the parents. Four students and their parents who did not complete the activities and abandoned the process were not evaluated in the final tests. During the implementation of the activities, the researchers visited the parents at home and had the opportunity to observe their efforts on site and intervened when necessary. At the end of the process, a library trip was organized by researcher with the students and their parents, they registered for the library membership, and the students have presented a book as a gift to ensure the continuity of the study.

For pre-reading, during-reading, and post-reading stages, varieties of parent-involved reading activities were implemented. For pre-reading, certain activities on mentally preparing learners and directing their attention and interest to the text were applied. For during-reading, the participating parents read aloud the text and the learners listened to them while paying attention to intonation and body movements. In this way, the learners were advised to picture what they hear in their minds so that interactive reading could be achieved. Then the learners read the text aloud and by themselves. Activities on evaluating and analyzing the text were used for post-reading. In one of the activities regarding post-reading, an activity called "Face of a Story" was used. In this activity, a visual map of the story is created. The learners visualized the characters, the plot, and events in the form of a map. In this way, they summarized the story that they have read in an analytical way.

Participants

The group of participants was composed of fourth-graders studying in two different primary schools in the central district of Muş province in Eastern Turkey. According to the data published by the Turkish Statistical Institute, one of these schools were in a neighborhood with low socioeconomic status, while the other schools were in a neighborhood with high socioeconomic status. These schools were selected is to ensure maximum diversity, allowing the sample to better reflect the general student and parent population.

A total of 245 primary school fourth-graders were pre-tested to select the participants. In the light of the

data obtained from the pre-test, the individuals who were selected included a total of 115 students whose scores were lower than the mean score and were close to each other in the reading comprehension achievement test. A letter was sent to the parents of 115 students to inform them about the purpose and process of the study and invited them to participate in this endeavor. The parents who wanted to participate in the study were told that a training session for them would be held by the researchers. 60 parents said who said they wanted to participate. The contact information of these parents was received, and the day and time of the training were scheduled. A total of 50 parents participated in the training. Thus, the experimental group of the study consisted of the parents and their children who declared that they wanted to participate in the study voluntarily and attended the training for parents. Some demographic data about parents are presented in Table 1.

Table 1.
Demographic Characteristics of the Experimental Group Students' Parents

Variable		*f*	%
Age	22-31	9	18
	32-42	33	66
	42 and above	8	16
Relationship	Mother	24	48
	Father	23	46
	Brother	1	2
	Other	2	4
Profession	Housewife	20	40
	Employee	7	14
	Small business owner	9	18
	Public servant	14	28
Educational Level	Primary school graduate	21	42
	Secondary school graduate	6	12
	High school graduate	8	16
	Faculty / College graduate	9	18
	Master/Doctoral graduate	6	12
Income status	0-1600 ₺	18	36
	1601-2600 ₺	8	16
	2601-3600 ₺	13	26
	3600+ ₺	11	22
Number of Children	1	3	6
	2-3	26	52
	4-5	14	28
	5+	7	14
	Total	50	100

In Table 1, demographic characteristics of the parents of the students in the experimental group are given. According to the table, 66% of the parents are in the age range of 32-42, while 18% are over the age of 22-31, and 16% are over the age of 42. Regarding the relationship, 24 mothers, 23 fathers, one brother, one aunt, and one uncle participated in the study as parents. When the profession of the parents is examined, it is seen that 40% are housewives, 28% are public servants, 18% are small business owners, and 14% are employed in any workplace. When the educational levels of the parents are examined, 42% of the parents are primary school graduates, 18% are faculty or college graduates, 16% are high school graduates, and 12% are graduate students. The income status of the families is as follows: 36% of the parents are in the income range of 0-1600₺, 26% of them are in the range of 2601-3600 ₺, 22% of them are in the income range of 3600₺ and above, and 16% of them are in the income range of 1601-2600₺. It is seen in the table that 52% of the families consist of 2-3 children, 28% of them consists of 4-5 children, 14% of them consists of more than 5 children, while only 3 (6%) families have a single child.

On the other hand, the control group was formed as a result of pairing with the students in the same class who got scores close to the average scores of the students in the experimental group in the pre-test. This pairing aimed to keep the factors that may affect the research result under control and to ensure that the experimental and control groups were as equivalent as possible. Table 2 shows the distribution of the students in the experiment and control groups by gender.

Table 2.
Distribution of the Students in the Experimental and Control Groups by Gender

Groups	Gender	*N*	%
Experimental Group	Male	20	40
	Female	30	60
	Total	50	100
Control Group	Male	25	50
	Female	25	50
	Total	50	100

Data Collection Tools

Reading motivation scale: This scale was developed by Wigfield and Guthrie (1997) to measure children's reading motivation and adapted to Turkish by Yıldız (2010). Yıldız (2010) re-modeled the scale with confirmatory factor analysis (CFA) as part of an adaptation study and yielded a valid scale structure consisting of internal and external dimensions of motivation. As a result of his reliability analysis, he reported the Cronbach Alpha internal consistency coefficient as .84 for the whole scale, while it was found as .81 in the present study.

Reading attitude scale: This scale was developed by McKenna and Kear (1990) and adapted to Turkish by Kocaarslan (2016). It has a four-point Likert type rating and consists of 20 items in total. The scale has two

factors: reading for pleasure and academic reading. The first ten items of the scale measure the attitude towards reading for pleasure, while the last ten items are related to the attitudes towards academic reading. Four Garfield visuals are used in the grading, ranging between "Happiest Garfield", "Slightly Smiling Garfield", "Mildly Upset Garfield" and "Very Upset Garfield". Kocaarslan (2016) calculated the Cronbach Alpha coefficient of the scale as .88, while it was found as .78 in this study.

Reading comprehension test: The test was developed by Yıldız (2010) and consists of 28 multiple choice questions about an informative text and a narrative text. Accordingly, narrative and informative texts were also used in parent-involved reading activities. Yıldız (2010) reported the reliability coefficients of the test as .71 for the narrative part and .77 for the informative part. In this study, the reliability coefficients were found as .70 and .73, respectively.

Data Analysis

The data were analyzed using SPSS 23.0 Package program. In the analysis, it was first checked whether the data were parametric or non-parametric. Analyses of skewness, kurtosis and histogram graph were performed to see the distribution. When the parametric conditions were met, the Independent Samples t-Test was used to examine whether there was a significant difference between the experimental and control groups.

Findings

In this section, the pre-test and post-test scores of experimental and control group students in reading comprehension achievement, reading motivation and reading attitude scales were analyzed. To test whether the difference between the sample means is significant, independent samples T-test is used when the groups are normally distributed, while Man Whitney U test is used when it does not show a normal distribution. The T-test assumptions were checked to decide which test to use. In this context, a pre-test was administered to both groups and the groups were independent of each other. To examine the distribution of normality, skewness and kurtosis coefficients and histogram graph of the distribution were examined. The calculated skewness and kurtosis indices close to 0 within the limits of ± 2 are considered as evidence of the presence of the normal distribution (Tabachnick and Fidell, 2013).

Findings on Pre-test Scores

As is seen in Table 3, the values of skewness and kurtosis coefficients vary between +1 and -1 in both sub-dimensions and scale totals, which shows that the distribution is normal. According to the histogram graphs, the distribution of the scores in the sub-dimensions and the scale total scores is normal. Accordingly, the above assumptions are confirmed, and a t-test can be applied in the analysis of the scales.

As is seen in Table 4, there was no significant difference between the scores of the experimental and control groups in the reading motivation scale (t (98) = .710, p> 0.05), neither were there any significant differences between the groups in the sub-dimensions "intrinsic motivation" (t (87.75) = .472, p > 0.05) and "external motivation" (t (81,40) = .339, p > 0.05). As for the scores in the reading attitude scale, the groups did not differ significantly in the whole scale (t (98) = .499, p > 0.05), and in the sub-dimensions "reading for pleasure" (t (96,30) = .,955, p > 0.05) and "reading for academic purposes" (t (98) = .220, p > 0.05). Lastly, there was no significant difference between the mean scores of the experimental and control groups in the reading comprehension achievement test (t (98) =. 946, p > 0.05), and in its sections related to a narrative text (t (98) = .871, p > 0.05) and an informative text (t (98) = .971, p > 0.05). The pre-test results showed that the reading motivation, reading attitudes, and reading comprehension achievement of the groups were equal or close to each other before the experimental process.

Table 3.
Results of the Normality Distribution Analysis Based on the Pre-test

Variable	Skewness	Kurtosis	Standard Deviation	Average
Intrinsic Motivation	.150	-.273	.359	2.15
Extrinsic Motivation	.201	.176	.301	2.13
Reading Motivation Total	.203	-.011	.288	2.14
Reading for Pleasure	-.771	.045	.246	2.31
Reading for Academic Purposes	-.705	.753	.279	2.20
Reading Attitude Total	-.744	.524	.24	2.26
Narrative text	.077	.141	2.44	7.62
Informative text	.673	-.339	2.76	5.77
Reading Comprehension Total	.404	-.513	4.39	13.39

Findings on Post-test Scores

Similar to the analysis of the pre-test instruments, the assumptions were firstly checked in the post-test results. Skewness-kurtosis, standard deviation and mean scores obtained from the post-test are given in the Table 5.

The skewness and kurtosis coefficients presented show that the values in both sub-dimensions and scale-totals vary between +1 and -1, which indicates that the distribution is normal. According to the histogram graphs examined, it is possible to say that the distribution of the scores obtained from the scales and their sub-dimensions does not show serious deviations and is normally distributed. Accordingly, the assumptions are confirmed, and a t-test can be applied in the analysis of the scales.

As is seen in Table 6, there was a significant difference between the mean scores of the experimental ($\bar{X}$ = 3.31) and the control group ($\bar{X}$ = 2.53) in the reading motivation scale in favor of the experimental group (t (90) = .000, p < 0.05). In the intrinsic motivation sub-dimension of the scale, there was a significant difference between the mean scores of the experimental ($\bar{X}$ = 3.21) and the control group ($\bar{X}$ = 2.47), and this difference was also in favor of the experimental group (t (90) = .000, p < 0.05). As for the external motivation sub-dimension, a significant difference was observed between the experimental ($\bar{X}$ = 3.35) and the control group ($\bar{X}$=2.56) with the experimental group students outperforming the control group (t (90) = .000, p < 0.05). The η^2 value calculated for the whole scale was found as .42, which indicates a large effect size.

Table 4.
T-Test Results of Pre-Test Scores

Dimensions	Groups	*N*	$\bar{X}$	*SE*	*t*	*p*
Intrinsic Motivation	Experimental	50	2.18	.417	-.722	.472
	Control	50	2.13	.292		
Extrinsic Motivation	Experimental	50	2.15	.362	.962	.339
	Control	50	2.09	.223		
Reading Motivation Total	Experimental	50	2.14	.347	373	.710
	Control	50	2.12	.216		
Reading for Pleasure	Experimental	50	2.31	.263	-.057	.955
	Control	50	2.31	.230		
Reading for Academic Purposes	Experimental	50	2.23	.307	1.23	.220
	Control	50	2.16	.245		
Reading Attitude Total	Experimental	50	2.27	.267	.678	.499
	Control	50	2.24	.209		
Narrative text	Experimental	50	7.66	2.42	.163	.871
	Control	50	7.58	2.49		
Informative text	Experimental	50	5.76	2.67	.036	.971
	Control	50	5.78	2.88		
Reading Comprehension Total	Experimental	50	13.42	4.71	.068	.946
	Control	50	13.36	4.10		

Table 5.
Results of the Normality Distribution Analysis Based on the Post-test

Variable	Skewness	Kurtosis	Standard Deviation	Average
Intrinsic Motivation	-.071	-.772	.679	2.84
Extrinsic Motivation	-.074	-.808	.626	2.96
Reading Motivation Total	-.051	-.800	.602	2.92
Reading for Pleasure	-.003	-.794	.511	3.06
Reading for Academic Purposes	.013	-.575	.574	2.94
Reading Attitude Total	.088	-.762	.514	3.00
Narrative text	-.314	-,317	2.80	9.05
Informative text	.149	-.920	3.14	7.78
Reading Comprehension Total	.013	-.641	7.43	16.84

In the attitudes towards reading, there was a significant difference in favor of the experimental group when compared to the control group in their mean scores, $\bar{X}$ = 3.38 and $\bar{X}$ = 2.61, respectively, (*t* (90) = .000, *p* < 0.05). Regarding the sub-dimension "reading for pleasure", there was a significant difference between the mean scores of the experimental ($\bar{X}$=3.41) and the control group score ($\bar{X}$ = 2.70) in favor of the experimental group (*t* (90) = .000, *p* < 0.05). Concerning the sub-dimension "reading for academic purposes", a significant difference was observed between the mean scores of the experimental ($\bar{X}$ = 3.35) and the control group ($\bar{X}$ = 2.53), which was also in favor of the experimental group (*t* (90) = .000, *p* < 0.05). The η^2 value calculated for the whole scale was found as .56, which indicates a large effect size.

In reading comprehension, there was a significant difference between the mean scores of the experimental ($\bar{X}$ = 18.73) and the control group ($\bar{X}$ = 14.93) in which the experimental group students performed better (*t* (90) = .000, *p* < 0.05). In the section about the narrative text, there was also a significant difference between the mean scores of the experimental ($\bar{X}$ = 9.89) and the control group ($\bar{X}$ = 8.21) in favor of the experimental group (*t* (90) = .004, *p* < 0.05). As for the section about the informative text, a significant difference was also observed in the mean scores of the experimental ($\bar{X}$ = 8.84) and the control group ($\bar{X}$ = 2.53) in favor of the experimental group (*t* (90) = .001, *p* < 0.05). The η^2 value calculated for the whole test was found to be .13, indicating a moderate effect size.

Conclusion and Discussion

The main purpose of this study was to examine the effects of parent-involved reading activities on primary school fourth-grade students' reading comprehension skills, reading motivation and attitudes towards reading. In this section, the findings on the effect of family involvement on students' reading comprehension, reading motivation and attitude towards reading are summarized and discussed.

Positive Effect of Parent-Involved Reading Activities on Students' Reading Comprehension Levels.

The first research question was whether the difference between the reading comprehension post-test scores of the experimental and control group students was statistically significant. As a result of the analysis, it was seen that reading activities with parental participation had a positive effect on students' reading comprehension levels.

In the literature, there is evidence of a positive correlation between the level of parental involvement and reading comprehension. For example, Bond (2011) examined the relationship between family involvement and reading comprehension achievement, motivation and attitudes on primary school second and third-graders, reporting a positive effect of parental involvement on reading achievement, attitudes and motivation. York (2006), in his study investigating the effect of parental involvement on reading achievement, concluded that as the level of parental involvement

Table 6.
T-Test Results of Post-Test Scores

Dimensions	Groups	*N*	$\bar{X}$	*SE*	*t*	*p*
Intrinsic Motivation	Experimental	46	3.21	.603	6.28	.000
	Control	46	2.47	.533		
Extrinsic Motivation	Experimental	46	3.35	.530	7.90	.000
	Control	46	2.56	.431		
Reading Motivation Total	Experimental	46	3.31	.499	8.12	.000
	Control	46	2.53	.415		
Reading for Pleasure	Experimental	46	3.41	.413	9.27	.000
	Control	46	2.70	.314		
Reading for Academic Purposes	Experimental	46	3.35	.410	9.91	.000
	Control	46	2.53	.387		
Reading Attitude Total	Experimental	46	3.38	.367	10.77	.000
	Control	46	2.61	.313		
Narrative text	Experimental	46	9.89	2,66	2.98	.004
	Control	46	8.21	2.70		
Informative text	Experimental	46	8.84	3.01	3.43	.001
	Control	46	6.71	2.93		
Reading Comprehension Total	Experimental	46	18.73	4.87	3.69	.000
	Control	46	14.93	4.99		

increased, the level of reading achievement also increased. Moreover, in some studies in the literature, it is stated that parental participation contributes to the academic achievement and course performance of students in general (Bailey, 2017; Topor et al., 2010). In this context, positive results have been obtained in studies on parental involvement conducted at home and at school to improve reading and reading comprehension as an academic skill (Epstein, 2001; Baker, 2003; Mraz and Rasinski, 2007; Tonn and Wailheiser, 2007). However, in several studies, a positive relationship was not found between parental involvement and academic achievement (Okpala et al., 2001), whereas few studies reported a negative relationship (Hill and Tyson, 2009; Jeynes, 2005). The discrepancies in research findings may be because parents are not adequately trained to teach certain concepts or they are not familiar with the teaching methods in the studies concerned. However, instead of focusing on the relationship between the level of parental involvement and any academic skill without an intervention, the effects of practices in which parents regularly worked with their children through parent-involved reading activities were investigated in the present study. Therefore, in addition to the potentially positive relationship between parental involvement and reading comprehension, intervention programs aiming to enhance the level of participation can yield fruitful results. In this regard, communication channels between parents and school need to be further strengthened to enable the participation of parents.

Increased Reading Motivation Through Parent-Involved Reading Activities

The second research question of the study was whether the difference between the reading motivation post-test scores of the experimental and control group students was statistically significant. For this purpose, a reading motivation scale was applied to the students before and after the experimental process. As a result of the analyses, it was seen that the students in the experimental group obtained statistically significantly higher motivation scores than the students in the control group.

Although many dimensions have been proposed regarding the reasons or incentives that lead to reading, reading motivation is generally categorized as intrinsic and extrinsic (Unrau and Schlackman, 2006; Wigfield and Guthrie, 1997). Therefore, the data obtained from this study were examined in internal and external dimensions. Intrinsically motivated individuals read to explore the world of reading, find various topics that interest them, enjoy reading, struggle to cope with the difficulties they encounter, and improve their reading skills. Extrinsically motivated individuals are controlled by social needs, demands, or rewards. In this context, the family makes the most important social impact on children's motivation to read (Hughes-Hassell and Lutz, 2006; Millard, 1997). Previous studies have provided some evidence that parental involvement in reading activities and parents' beliefs about reading both have a causal effect on children's reading motivation and achievement and have correlation (Baker et al., 1997; Baker, 2003; Senechal and Young, 2008). For example, Capotosto et al. (2017) state that in their study examining the effect of family support on the reading skills, motivation and habits of third-graders, students who receive family support make progress in these aspects. Pavalache-Ilie and Ţirdia (2015), on the other hand, reported that school performance was significantly related to parental involvement and intrinsic motivation in their study examining the relationship between parent involvement, school performance and intrinsic motivation of primary school third and fourth-graders. The results of the present study also show that parental involvement is related to student motivation. The fact that reading activities with parental participation increase students' reading motivation confirms the findings in the literature. However, in this paper, there was structured parental involvement and support present through activities at home with an experimental approach. In this respect, the present study is believed to provide stronger evidence in the literature. In addition, different results have been reported from the studies conducted on different age groups and grade levels in the literature. For instance, Coleman and McNeese (2009) examined the relationship between parent involvement, student motivation and academic achievement and found a positive relationship between student motivation and academic achievement, and a negative relationship between parent involvement and motivation. This can be explained by the age and maturity level of the students. Some students enter puberty at this age and tend to be more and more independent. Children may have wanted less involvement from their parents, wanting to be less dependent on them. In this context, it can be said that parental involvement can be more effective in pre-school and primary school periods.

Improved Attitudes Towards Reading Through Parent-Involved Reading Activities

The third research question of the study was whether the difference between the experimental and control group students' reading attitude post-test scores was statistically significant. For this purpose, an attitude scale towards reading was applied to the students before and after the experimental process. As a result of the findings, it was seen that reading activities with parental involvement had a positive effect on students' reading attitudes.

The attitudes towards any object or situation can be affected by the socialization process, the

characteristics of the group to which one is a member, or the social class, in addition to the individual's genetic factors, physiological conditions, personality, beliefs or a direct experience (Baysal, 1981; Vaughan and Hogg, 2005). In short, your attitude towards something is a plural conceptualization that changes in the context of culture, environment, and purpose (Aizen and Fishbein, 2005). Here comes the importance of family because the family is the most important environment in which the child's personality and emotions develop. The results regarding the effect of parents on reading habits and attitudes in the literature confirm the findings of the present study. Özbay (2006) asserts that the attitudes of family members are quite important in reading education, and the family's attitudes towards books at home and their activities to make the child love reading positively affect the child's attitudes towards reading. Kaldan Sabak (2007) aruges that the environment in which the individual lives affect his or her acquisition of a reading habit. Topçuoğlu Ünal and Yiğit (2014) found that the family plays an important role in the formation of a reading culture in children. Durualp and Çiçekoğlu (2013) reported that parents' reading books had positive effects on increasing children's reading attitudes. In this context, it can be said that the positive emotional and behavioral tendency of the family towards reading activities also affects the child's attitude positively. During the experimental process of the present study, children read together with their parents for eight weeks, answered questions about the texts, and completed various activities within parent-involved reading activities. The parents provided direct support to the children in the implementation of the activities. It can be stated that reading comprehension activities in which the parents participate and take responsibility has the potential to create positive changes in children's attitudes towards reading.

Suggestions

In this section, suggestions are offered taking into account the results and limitations of the present study:

- Within the scope of this study, the effects of parent-involved reading activities on students' reading comprehension skills, reading motivation and attitudes towards reading were tested, and positive results were yielded. In further studies, researchers can also develop parent-involved activities for different courses and skills and examine their impact at primary school level.
- In this study, the effects of parent-involved reading activities on reading comprehension skills, reading motivation and attitudes towards reading are limited to fourth graders and their families. The impact of these activities can be reconstructed for different grade levels and examined with a larger sample.
- Teachers can plan activities to enable parent-involved reading at home and school and organize home visits, and parents can be encouraged to take part in committees such as school-parent unions.
- Within the scope of this study, training was given to the parents to ensure their participation and to inform them about the nature of the reading activities. To enhance parental involvement, similar educational seminars can be organized for parents, and they can be informed about how they can support their children.
- This study is limited to an implementation period of eight weeks. Through a longitudinal study on this issue, effects can be examined over a longer period.
- In this study, the reading activities with parental involvement were to strengthen family participation at home. Studies can also be conducted to enable this participation at school.
- Studies with comparative analyses can be conducted to evaluate results from families with different socioeconomic levels.
- In this study, the effect of reading activities with parental involvement was analyzed using an experimental design, and employing a reading comprehension achievement test, reading motivation scale, reading attitude scale. Studies that provide more detailed data on this subject can be conducted using different methods (e.g. action research) and scales.

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Predictors of The Subjective Effectiveness of Emergency Remote Teaching During The First Phase of The COVID-19 Pandemic

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Abstract

Worldwide school closures which were happening during the first phase of the COVID-19 pandemic in spring 2020 created a great lesson about the conditions for effective teaching. As temporary school closures seem very likely to occur in the forthcoming school year(s), at least locally, it is worthwhile to exploit this lesson to learn more about the capacities and resources that can be utilised in both emergency remote teaching (ERT) and regular teaching, beyond the pandemic.

This research was initiated in the third week of ERT, on 13 April 2020, and involved 154 teachers in 87 schools in Poland. Its purpose was to identify predictors of subjective effectiveness of emergency remote teaching (SEERT) that might be important for remote teaching pedagogy in general. The results show that the best predictors of the SEERT are self-efficacy, digital competence and peer support from other teachers. The situation of the pandemic in a sense confirms the key role of transferable resources in the performance of teachers' professional duties and sets a path for strengthening these in teacher training and continuing professional development programmes to increase capacity for both regular and remote teaching.

Keywords:
Emergency Remote Teaching (ERT), COVID-19, Teachers' Subjective Effectiveness, Peer Teachers' Support, General Self-Efficacy, Digital Competence

Introduction

Education during the pandemic

On 11 March 2020, the World Health Organisation declared a state of worldwide pandemic of the disease COVID-19, which was caused by the severe acute respiratory syndrome coronavirus (SARS-CoV-2). As of late July 2020, the virus was present in every single country in the world and the number of cases exceeded 14 million. The pandemic was connected with extensive school closures which started in February 2020, and were in force in various forms for months to come.

Teachers demonstrated remarkable resilience, flexibility and commitment to education during the pandemic. Thousands of them immediately started their adventure with emote education, which is usually described as 'a formal learning activity conducted when teachers and students are separated by (geographical or temporal) remote and supported by communication technologies – TV, computers, e-mail' (Appana, 2008, p. 5) and/or online learning, meaning education based on the internet as the main means of delivering information and communication. However, according to Hodges et al. (2020) this type of sudden change from bricks-and-mortar to distance teaching should instead be called emergency remote teaching (ERT). The pandemic revealed that teachers' familiarity with integrating technology into instructional practice was still limited and they had various levels of readiness to engage in online teaching and even in professional development using technology. The OECD study from March and May 2020 (Reimers & Schleicher, 2020) suggests that teachers are convinced that the effectiveness of remote education might be poor: almost half of the respondents indicated that it is not possible to assess the effectiveness of remote education, and 32% said that students learned less than they would have normally learned at school. Research involving Polish teachers (Librus, 2020) showed that 59% of them evaluate the effectiveness of remote teaching as low. This certainly has consequences for the engagement of the students and the effectiveness of the teaching and learning process. Therefore, taking into account the present need to return to online education, it is important to identify the factors responsible for the effectiveness of teaching (as perceived by teachers). Working in this area can enhance the resources that allow teachers to transfer their standard professional activities more effectively to the online environment.

Different goals were formulated for remote education during the pandemic, but the 'Maslow before Bloom' (Doucet et al., 2020) principle remained prevalent, which emphasised the importance of caring for students' integral development, both in regular and extraordinary teaching situations (Domagała-Zyśk, 2018; Domagała-Zysk & Knopik, 2019). In emergency pandemic teaching, apart from facing serious difficulties in ensuring student participation and engagement, teachers were faced with the necessity of acting as 'emergency units' to support the well-being of students who experienced severe challenges such as the serious illness or death of family members, digital exclusion, intensification of cyber-bullying, loneliness, and depression (cf. Ptaszek et al., 2020). Teachers were also supposed to be effective at taking on-the-spot remedial measures, particularly for students with special needs, an inability to access e-learning, and/or a high risk of dropping out. In many situations it was not possible for teachers to fulfil all these requests and, as the studies show (Ptaszek et al., 2020), teachers' level of digital hygiene and general well-being was incredibly low.

An important element directly affecting the effectiveness of remote teaching during the pandemic was the transparency and order of activities at the level of a specific school. Błaszczak, Knopik, & Maksymiuk (in press) found that about 65% of the 482 parents they surveyed observed a methodical chaos in teachers' actions, caused by three main factors: a lack of common solutions at the level of a given institution (i.e. each teacher had their own strategy for remote teaching); substantial variability in the actions of a given teacher (frequent organisational changes, lack of adaptability); and poor communication with students and parents (delivering instructions through various channels in unclear and inconsistent ways). It can therefore be concluded that schools whose organisational culture was conducive to teamwork and co-operative learning before the pandemic have more easily coped with the development and implementation of a coherent remote learning system, resulting in more constructive communication with students and parents (Bush & Grotjohann, 2020).

Subjective teacher effectiveness

Teacher effectiveness is commonly understood as the capability of teachers to influence their students' educational outcomes. Palardy and Rumberger (2008) propose three dimensions of teacher effectiveness: instructional practice, teachers' attributes (such as enthusiasm for teaching and supporting students' achievements), and teachers' background characteristics, like years of experience or certification. Most commonly, teacher effectiveness is measured by external factors, e.g. student achievement (Doherty & Jacobs, 2013) or certain characteristics of learners such as motivation, engagement, persistence, self-efficacy or self-concept (Irvine, 2019).

'Subjective teacher effectiveness' can be understood as the degree to which teachers believe they can lead their students and influence their learning. It can be seen as a teacher's belief in his or her own teaching ability including preparation of materials, classroom management and assessment (Chang, 2012). For the purposes of this study, this term is narrowed to 'subjective effectiveness of emergency remote teaching', which is more precise and takes teaching conditions into account. This term can be defined as teachers' belief in their competence to teach in a remote mode so as to equip the students with the necessary knowledge and skills while ensuring that their emotional and social needs are met during the pandemic. Based on respondents' assessments of this belief, we adopt a subjective measure of teaching effectiveness (cf. Jacob & Lefgren, 2008).

Teachers' self-efficacy (TSE)

The effectiveness of strategies of educational continuity in the pandemic depended mostly on teachers' creative engagement, a competency which itself depends upon teachers' self-efficacy (TSE). Bandura defines self-efficacy as a set of 'people's judgments of their capabilities to organise and execute the courses of action required to attain designated types of performance' (1986, p. 391), and as individuals' beliefs in their capability to exercise control over challenging demands (1997). It is regarded as a multidimensional and context-specific construct (Skaalvik & Bong, 2003; Zimmerman & Cleary, 2006), grounded in the social cognitive theory that characterises humans as agents who can exercise some influence over what they do, and can form intentions, set goals, anticipate likely outcomes, monitor and regulate actions, and reflect on their personal efficacy (Bandura, 2006). Efficacy beliefs determine how people perceive opportunities and impediments, what courses of action they take and how perseverant they are when encountering barriers and difficult situations. A teacher's self-efficacy is widely recognised as their belief in their ability to influence students' outcomes (Wheatley, 2005) and plan, organise and carry out the activities required to attain given educational goals (Skaalvik & Skaalvik, 2007, p. 612). Following Bandura's (1997) social grounded theory, teachers' self-efficacy may be conceptualised as the confidence that one can employ the skills necessary to deal with job-specific tasks and cope with job-specific challenges and job-related stress. This is predictive of both teachers' practices and students' learning, and was found to correlate positively with perceived success, academic optimism, and hope (Sezgin & Erdogan, 2015); and negatively with teacher burnout (Skaalvik & Skaalvik, 2007; Kim & Burić, 2019, Schwarzer & Hallum, 2008; also see the metaanalysis by Shoji et al., 2015) and job-related stress (Gonzaleza, Petersb, Orangec, & Grigsbyd, 2017; Schwarzer & Hallum, 2008). Teachers' self-efficacy has also been examined in relation to high-stakes testing and educational triage (Gonzaleza et al., 2017); school leadership style (Gonzaleza et al., 2017; Fackler & Malmberg, 2016); students' achievements (Fackler & Malmberg, 2016); and students' motivation, satisfaction, confidence, and attitudes towards school (Zee & Koomen, 2016). It can be also moderated by teacher's age, seniority, type of school or the number of children in school (Bay, 2020).

Teachers' digital competence for remote teaching

Teachers' digital competence entails a set of skills (cf. Hinojo-Lucena et al., 2019) connected with communication and data literacy, online collaboration, digital content creation, digital security and problem solving. While some researchers argue that online teaching competencies are not substantially different from those used in face-to-face instruction (Bawane & Spector, 2009), others suggest that online teaching needs a different set of digital and pedagogical competencies, like virtual management skills and the ability to provide technological assistance and engage students through virtual communication (Easton, 2003).

For some years now, scientists have been aware of the fundamental significance of digital competence for teachers' sense of effectiveness and their students' educational success. Teaching effectiveness has been found to be connected with the intention to use technology (Anderson, Groulx, & Maninger, 2011; Banas & York, 2014; Valtonen et al., 2015); with digital competence and the use of ICT in schools (Hatlevik, 2017); and with teachers' innovative behaviour (Klaeijsen, Vermeulen, & Martens, 2018). Efficient ICT competences allow teachers to focus on subject content instead of technical support.

Remote teaching is education that takes place across distance and not in traditional bricks-and-mortar classrooms. It does not include in-person interaction between the teacher and students, as they work in different locations. It is understood not as a variation of teaching style, but a method of delivering instruction entirely online. Means, Bakia and Murphy (2014) proposed a model of online teaching and learning that includes nine dimensions: modality (fully online, blended, web-enabled face to face), pacing (open entry and exit or others), student-instructor ratio, pedagogy used by the instructor (expository, practice, exploratory or collaborative), role of online assessment, instructor and student's online communication synchrony (asynchronous or synchronous teaching), and type of feedback. All of these aspects should be carefully considered and planned before starting a remote course. Unfortunately, the pandemic situation of 2020 did not provide teachers with time to prepare for this tremendous change from teaching on-site to teaching online. Therefore, the remote teaching that took place during the first wave of the pandemic (spring and summer 2020) should be called emergency remote teaching (ERT, Hodges et al., 2020), which is defined as a temporary shift in instructional delivery to an alternate delivery mode due to crisis circumstances. It is characterised by a high level of improvisation and quick solutions in less-than-ideal circumstances and an extremely narrow preparation window. However, remote teaching competencies should become part of teachers' skill sets so that they will be prepared to incorporate remote teaching methods into their repertoire during future crisis situations.

Digital competence and skills are part of the Polish primary and secondary curriculum and teachers should be equipped with them before entering the classroom, but not enough has been done to prepare

new and in-service teachers for the implementation of this curriculum (Plebańska, 2017). ICT is still new and unfamiliar to many teachers; in a recent study by Ptaszek et al. (2020), almost half of the teachers (N = 671) said that they were not prepared for online teaching, and that they employed mainly static, non-interactive methods like sending a link to a film or a worksheet to be printed and completed by the students offline (cf. Librus, 2020).

Teachers' stress

Stress is a negative affective experience, a psychological reaction to environmental conditions that produce threats to well-being (Lazarus, 2006), and is often related to one's ability to cope with job-related tasks. While some level of positive stress – eustress – makes our work feel dynamic, negative stress – distress – implies that the work tasks are not seen as challenges but as threats and barriers (Skaalvik & Skaalvik, 2016). Teaching was regarded as one of the most stressful professions even before the pandemic (Johnson et al., 2005), because of heavy workloads, bureaucracy, time constraints, fear of evaluation, low professional self-esteem, and difficulties in maintaining a work-life balance (Mercer & Gregersen, 2020).

The global pandemic heightened teachers' stress level tremendously: it forced widespread school closures requiring immediate mastery of new technology and meant that many teachers had to instruct students while managing difficult conditions at home, teaching their own children, and/or taking care of elderly family members at high risk of developing severe illness. The potential stressors are thus numerous: the threats to their own and their students' health; the need to combine work and home life, often as parents themselves; pressure from school leaders; meeting students and parents' requirements in terms of the methods for conducting classes; and fear of negative external evaluation of their work (e.g. stressors brought forth by exam-based accountability policies, von der Embse et al., 2016). Teachers' stress and exhaustion was also triggered by the initial chaos of remote teaching. During this time, teachers were inundated with emails, texts and calls from principals, parents and students who expected them to provide clear explanations and guidance, while they themselves were experiencing cognitive dissonance caused by rumours, disinformation, and conflicting expert opinions (cf. Bin at al., 2020). Online delivery of courses can also blur the physical, temporal and psychological boundaries between school and home (MacIntyre, Gregersen & Mercer, 2020). Another stressor was being confined to the home during the lockdown and being unable to take part in physical activity, which is so important for physical and mental health.

Support from peer teachers and school leaders

Even without the challenges of the pandemic, many teachers struggle to meet the differentiated needs in their classrooms. Peer support and mentoring programmes offer help to teachers coping with these demands (White, 2018; Birney et al., 2018; Rachamim & Orland-Barak, 2018). Research reveals that competent support from colleagues predicted increases in teacher efficacy (Jungert et al., 2019). Many teachers believe that working in teams with colleagues, planning collaboratively, and achieving goals together contributes to their job satisfaction and sense of security at work (Edinger & Edinger, 2018). Support from colleagues boosts teachers' resilience and ability to deal with difficult situations (Castro, Kelly, & Shih, 2010). The most important element was the peer teacher's availability ('it felt like the peer support teacher was only an e-mail or telephone call away to provide support as needed', White, 2018). Online peer support was found to strengthen pre-service teachers' preference for collaborative learning and sharing (Liu, 2020; Hur, Shen, & Cho, 2019), and increase their self-efficacy for technological integration and intercultural sensitivity (Hur, Shen, & Cho, 2019).

Australian and Australasian experiences can be of a particular value when learning from the pandemic's challenges, as online learning communities were being established to provide teachers with peer support even before the crisis (Paris, Boston, & Morris, 2015), and were found to reduce the impacts of isolation, vulnerability and anxiety. These communities are of particular value for pre-service teachers who may share resources and strategies with more experienced staff and receive online support when their remote learning environment seems unsupportive (Mercieca & Kelly, 2018).

School leaders are responsible for creating vivid learning communities where teachers – feeling acknowledged and supported – are able to care intensively about their students' learning and well-being. The research shows that teachers need their school leaders' support mainly in the context of managing conflict and dealing with students' diversity (Harju & Niemi, 2018). During the pandemic ERT especially the issue of teachers addressing students' diverse needs definitely required support from school leaders.

Method

Research aim and questions

The aim of the study was to identify predictors of subjective effectiveness of emergency remote teaching (SEERT) that might be important for remote teaching pedagogy in general. The research was to answer the following questions:

RQ1: What strategies did the teachers use in emergency remote teaching (ERT) during the first four weeks of the COVID-19 pandemic?

RQ2: How did teachers evaluate the subjective effectiveness of emergency remote teaching (SEERT) and what are the predictors of their evaluation?

RQ3: Are there any significant differences in the following variables between teachers working at different levels (primary grades 1-3, primary grades 4-8, and secondary school):

1) effectiveness of teaching and effectiveness of education for students' well-being;

2) general self-efficacy (GSE, understood as a general sense of control over the actions taken);

3) peer support from other teachers and school leaders;

4) teachers' stress levels; and

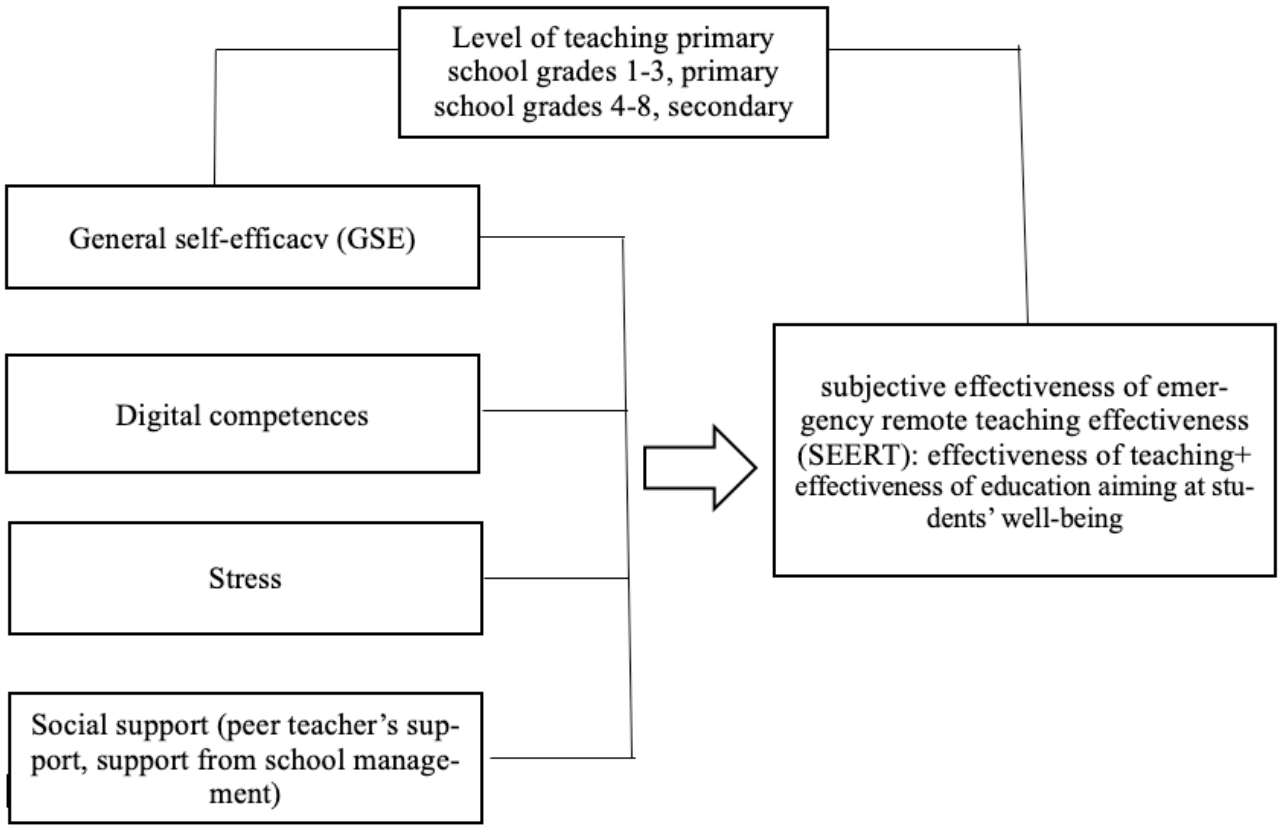
5) teachers' digital competences

The variables are presented in Figure 1.

The study participants

In the study, 162 teachers took part but the final analysis included only the fully completed questionnaires, of which there were 154 (from 127 women and 27 men). The average age of the respondents was 43.46 years, while the average length of teaching experience was 16.94 years. As shown in Table 1, the study included teachers working at primary schools (where two educational stages are distinguished in the Polish system: classes 1-3 - integrated teaching and 4-8 - subject based teaching and secondary schools. Respondents were selected from these three stages of education because of fundamental differences in teaching experience. In grades 1-3, integrated teaching is usually conducted by one teacher. In grades 4-8, individual subjects are taught by different teachers and the frequency of classes in a given subject is similar across the country. Teaching in secondary school is highly diversified between schools and assumes a high level of student independence. The teacher training programs are also diverse: for elementary education candidates have to study in long 5-year courses, where not only content issues on key skills but also plenty of hours is devoted to psycho-pedagogical support for students. Subject teachers usually study in bachelor programmes on different subject and then they participate in 350-hour (45 ECTS) course on psycho-pedagogical teacher preparation. either simultaneously (55%) to their subject studies or in postgraduate courses (45%, MEiN 2019). This may mean that subject teachers are not equipped well enough into pedagogical competences that would allow them to offer support for their students or create

Figure 1.
Theoretical model presenting selected conditions of SEERT



communities of care, especially for the students in traumatic of crisis situations (Keown, Carroll, Raisor 2020) or school environments recognized as peaceful, happy and encouraging (Calp 2020).

Table 1.
Type of teaching experience

	Type of teaching experience	*N*	%
1	Primary schools grades 1-3 – elementary education	41	26.6
2	Primary schools grades 4-8 – subject teaching	76	49.4
3	Secondary schools – subject teaching	37	24.0
	Total	154	100

The respondents represented 64 primary schools and 23 secondary schools in both rural areas (41 institutions) and urban areas (46 institutions).

Measures and procedure

The research was conducted by sending to participants an online form that included two tools: a) a bespoke 34-item survey on various aspects of remote teaching; and b) the Generalised Self-Efficacy Scale, or GSES (Schwarzer, 1993). The variables included in the first tool are listed in Table 2.

The second tool was the GSES, which was created by Schwarzer to assess a person's individual performance and sense of control over their actions. The GSES is a 10-item scale that studies generalised efficacy without referring it to specific behaviours and situations (thus providing an opportunity to evaluate the role of a generalised sense of efficacy in the assessment of individual activities). The task of the respondent is to react to each item by selecting one of four answers: 1 – disagree, 2 – somewhat disagree, 3 – somewhat agree, and 4 – agree. The score therefore ranges from 10 to 40 points, with a higher score indicating greater self-efficacy.

The psychometric coefficients of the Polish adaptation of the GSES can be considered satisfactory (cf. Juczyński, 2001). Internal compatibility was established on the basis of a study of 174 individuals aged 25 to 55 (Cronbach's alpha coefficient was 0.85). The reliability of the tool was checked by using the test-retest paradigm (using a 5-week interval) on a group of 85 participants. The value of the correlation coefficient was 0.78. GSES normalisation was carried out on a sample of 496 people aged 30 to 55.

Our research started in the third week of school closure in Poland and was conducted for 10 days. Apart from the 34-item survey and GSES, the online form included an additional open question about the potential benefits of remote teaching.

Results

The analysis shows that the teachers' most frequent strategies for ERT were sending links to methodological materials and sending students instructions over the internet (communicators). Telephone calls with pupils and parents were the least frequent (see Table 3). The average time spent on remote teaching in one day was 5.92 hours[1].

The overall level of SEERT can be considered moderately high (M = 5.76 on a scale of 1-8). A slightly higher level of teaching effectiveness in relation to activities aiming at students' well-being was observed (see Table 4). The differences are statistically significant (Wilcoxon signed-rank test: Z = -3.486, p < 0.001).

Table 2.
Variables analysed in the 34-item survey

Description of variable	Number of items	Format or way of answering
Sociodemographic (sex, age, workplace, place of residence, seniority, subject taught)	6	Open questions
Conditions for implementation of distance teaching (e.g. equipment, cooperation with other teachers, guidelines from school management and the Ministry of National Education)	16	Scale from 1 (not applicable) to 4 (fully applicable)
Subjective evaluation of the effectiveness of distance education	2	Scale from 1 (low) to 4 (high)
Subjective evaluation of the effectiveness of time spent on distance teaching as compared to time spent in classroom teaching before the pandemic	1	Percentages (e.g. 50% indicates that the effectiveness of distance teaching is half that of the education on site)
ICT competences	1	Scale 1 (very poor) to 5 (very good)
Stress level	1	Scale from 1 (very high stress) to 5 (very low stress)
Time devoted to distance teaching	1	Number of hours
Frequency with which distance teaching methods were used	8	Average number of times per day on a scale of 1 (at least once a day) to 6 (six or more times a day)

Table 3.
Frequency of using distance teaching strategies

	Strategy	*M*	*SD*
1	Sending materials to be completed by students	3.56	1.271
2	Instructions sent via the electronic school journal	2.88	1.02
3	Phone calls to parents /pupils	2.72	1.08
4	Using online communication (e.g. Skype) to send instructions	3.95	1.91
5	Online tests	2.88	1.11
6	Sending links to ready-made teaching materials	4.35	1.47
7	Webinars/online classes	3.62	1.54

Table 4.
The level of subjective effectiveness of emergency remote teaching (SEERT)

Variables	*M*	*SD*
effectiveness of teaching	2.87	1.068
effectiveness of education aiming at students' well-being	2.60	.949
SEERT	5.76	1.511

An analysis of the relationship between the frequency of a particular strategy and the assessment of SEERT suggests that only two strategies were statistically significant: online tests and interactive lessons (webinars and online classes, see Table 5). This shows that these remote-learning methods, which may allow students to get as close as possible to the educational practices they experienced before the suspension of classes, have a positive impact on the SEERT as made by teachers. An important feature that these two methods have in common is the high level of teacher-student interaction that they involve, which allows the teacher to have more control over the teaching process (cf. Watson et al., 2012). There is no significant correlation between time spent on remote teaching and the assessment of SEERT.

An analysis of the relationship between SEERT and stress level, GSE, and level of support from peer teachers and school management indicates statistical significance for GSE and social support (Table 6). The correlation between stress and SEERT is significant at $p < .05$. This means that SEERT has somewhat of a tendency to decrease as stress levels increase.

In order to identify the predictors of SEERT, a stepwise regression analysis was conducted. It shows that the variables that best explain the effectiveness of remote teaching understood as the combined result of subjective evaluation of the effectiveness of the core curriculum implementation (subject knowledge) and education aiming at the development of students' well-being and emotional and social competences, preventive measures, value shaping etc. are: overall

Table 5.
Correlation coefficients (rho Spearman's) for variables: SEERT (subjective effectiveness of emergency remote teaching), frequency of use of a given method and time devoted to emergency remote teaching (ERT)

Variables	SEERT	Sending materials to be completed by students	Instructions sent via the electronic school journal	Phone calls to parents / pupils	Online communication (e.g. Skype)	Online tests	Sending links to ready-made materials	Webinar/online classes	Time devoted to ERT
SEERT	1.000								
Sending materials to be completed by students	0.066	1.000							
Instructions sent via the electronic school journal	0.009	0.215*	1.000						
Phone calls to parents /pupils	0.090	0.409**	0.048	1.000					
Online communication (e.g. Skype)	0.127	0.248**	-0.202*	0.317**	1.000				
Online test	0.369**	0.221*	0.059	0.081	0.258**	1.000			
Sending links to ready-made materials	0.187	0.448**	0.091	0.314**	0.379**	0.411**	1.000		
Webinar/online classes	0.348**	0.235*	0.042	0.182	0.500**	0.428**	0.514**	1.000	
Time devoted to ERT	0.017	0.149	0.088	0.082	0.111	0.007	0.115	0.187*	1.000

* Correlation is significant at the 0.05 level (2-tailed)
** Correlation is significant at the 0.01 level (2-tailed)

effectiveness (as measured with the GSES), peer support from other teachers, and digital competence. In total, these factors explain 33.2% of the effectiveness variance (see Table 7).

Analyses of the differences between groups of respondents at different teaching levels (grades 1-3, grades 4-8 and secondary school) in terms of stress severity, GSE level, SEERT (two aspects), social support and digital competence (see Table 8 and 9) show the following results:

a) The stress intensity level was highest among teachers of grades 4-8, and lowest among secondary school teachers ($p < 0.05$);

b) Effectiveness of education for students well-being was highest among secondary school teachers and lowest among teachers of grades 4-8 ($p < 0.05$);

c) Support from peer teachers was highest among teachers of grades 1-3, and lowest among secondary school teachers ($p < 0.01$).

Table 6.

Correlation coefficients (rho Spearman's) for variables: SEERT, stress level, GSE and level of peer support

Variables	SEERT	Stress level	GSE	Peer teachers support	Support from school management
SEERT	1.000				
Stress level	-0.181*	1.000			
GSE	0.516**	-0.330**	1.000		
Peer teachers support	0.266**	-0.207**	0.028	1.000	
Support from school management	0.101	-0.017	0.063	0.358**	1.00

Table 7.

Predictors of SEERT in stepwise models

Model		Unstandardized coefficients		Standardized coefficients		R^2	R^2 change	F	p
		B	SE	Beta	p				
1	GSE	.142	.021	.488	<0.001	.239	.234	47.614	<0.001
2	GSE	.140	.020	.484	<0.001	.311	.302	64.107	<0.001
	Peer teachers support	.432	.108	.270	<0.001				
3	GSE	.160	.020	.552	<0.001	.345	.332	26.386	<0.001
	Peer teachers support	.367	.108	.229	<0.001				
	digital competences	.284	.101	.201	.006				

Table 8.

M and SD for selected variables in groups of teachers of different levels of teaching

Level		Peer teachers' support	Support from school management	GSE	SEERT		Stress	Digital competence
					Effectiveness of teaching	Effectiveness of education for students' well-being		
Primary school grades 1-3	*M*	2.95	3.00	31.20	2.78	2.76	3.20	3.71
	SD	.921	0.87	4.66	.852	.888	1.20	.782
Primary school grades 4-8	*M*	2.39	2.81	31.97	2.72	2.39	3.61	3.42
	SD	.910	0.92	5.54	1.18	.925	1.21	1.158
Secondary school	*M*	2.36	3.08	34.03	3.08	2.89	2.97	3.33
	SD	.990	0.97	5.03	.996	1.01	1.10	1.20

Table 9.
Significance test of differences (Kruskal-Wallis test) between groups of teachers of different levels

	Peer teachers' support	Support from school management	GSE	Effectiveness of teaching	Effectiveness of education for students' well-being	Stress	Digital competence
H	9.642	0.908	5.760	3.037	8.112	7.119	1.894
Asymptotic significance	.008	0.341	.056	.219	.017	.028	.388

Discussion

The teachers demonstrated a moderately high level of SEERT. Statistical significance was found for the higher level of teaching effectiveness in terms of transmitting knowledge, as compared to developing well-being and social and emotional skills. This proves that online education as experienced by the participants was more effective for imparting subject knowledge than nurturing students' emotional and personal competencies. An analysis of dominant online learning strategies (sending links and instructions to learning activities) shows that they address students' cognitive needs, but not their needs for general well-being, social relationships or personal development.

Amid efforts to sustain educational continuity during the period of physical distancing, the research has shown that the three most important predictors of SEERT are: high levels of generalised self-efficacy (GSE), support from peer teachers, and digital competencies. These results should be seen not only in relation to the pandemic, but in a broader perspective of teachers' professional effectiveness and the goals of teacher training programmes. The key issue for teachers' GSE seems to be the transferability of resources. Transfer in learning and transferable resources are revealed when previous knowledge and skills influence the acquisition of new competencies (Justice, Rice, & Warry, 2009). Transferable resources impact on one's level of self-efficacy and can be considered universal competences that build one's adaptive potential (Billing, 2007; Magne & Deci, 2005). This potential is crucial when a person faces an unexpected challenge; it enables them to stay positive and creatively cope with the new situation. This has a direct implication for teacher training programmes: in future emergency situations, trainees who are equipped with transferable resources that enhance their self-efficacy will be able to cope with the emerging difficulties.

This effectiveness in dealing with difficult situations is strengthened by social support, which in each new situation allows for shared responsibilities, joint development of cooperative learning strategies, and use of common resources. The most common benefit of remote education indicated by the respondents, apart from increasing student autonomy, was the possibility of solving problems together with other teachers. This confirms the importance of peer support at both the intellectual and emotional level. Analyses indicate that social support was highest for teachers of primary grades 1-3, which is consistent with the generally more collaborative nature of work at this level of education.

An additional factor influencing the effectiveness of teaching is digital competence, i.e. the knowledge and skills that allow teachers to adapt to the new online paradigm. The lack of these skills significantly limits their possibilities for action, which translates into less effectiveness. According to international research (Fraillon et al., 2020; cf. Fraillon et al., 2013), the level of teachers' digital competence varies greatly across individuals and education systems, in part because teachers' professional development rarely includes formal training in digital skills. Our results confirm that teachers tend to use new technologies in the classroom for routine tasks, such as presentations or information retrieval, rather than for more complex ones related to the process of acquiring knowledge and skills, such as simulation, modelling, and concept-mapping (Fraillon et al., 2013, 2020). The analysis shows that the teachers' most frequent digital strategies in ERT were basic ones, like sending instructions or links to methodological materials. On the other hand, a significant positive relationship was demonstrated between SEERT and such digital strategies as online tests and webinar classes. These activities require more advanced digital competencies, but at the same time allow teaching to be conducted in accordance with a standard similar to on-site education.

According to self-determination theory (Deci & Ryan, 2012), a person's internal motivation and effectiveness are impacted by the extent to which three fundamental needs are met: belonging, autonomy and competence in the environment where the person lives and works. Our results support this and outline a more general recommendation concerning strengthening teachers' personal resources so that they are better prepared to cope with new situations (including successive waves of the pandemic and other crises which may suddenly appear and dramatically change the existing rules of societal functioning). On the one hand, therefore, the long-term process of building self-efficacy is

strongly connected with shaping the image of oneself (including the processes of forming self-knowledge and self-esteem), which can be strengthened through psychological support, supervision, and personal development workshops (an area that is absent from the Polish model of teachers' professional development programmes, cf. Chrzanowska, 2020). On the other hand, the continuous development of professional competences is consistent with the trend of modern communities placing more emphasis on digital skills, pro-ecological policies, and intercultural education. The shaping of intrapersonal resources should be strengthened by generating a culture of teamwork, in which a single teacher does not have to face challenges on his or her own every time, but can count on the constructive support of peer teachers (Drossel et al., 2019).

The results also show that although there are no statistically significant differences in GSE levels among the primary and secondary teachers, there are differences in educational effectiveness. The lowest level of effectiveness is found among teachers of grades 4-8, which may reflect that the specific developmental needs of students in early adolescence are quite difficult to meet through remote teaching. The analysis of supportive methodological materials provided to teachers in Poland shows that they contain almost no content referring to students' emotional and social needs, but focus only on cognitive aspects and subject matter. This finding, and the observed differences between teacher groups, indicate that the provision of preventive materials can be identified as a gap in remote teaching. It also turns out that teachers from grades 4-8 feel the most stress associated with the pandemic and the implementation of remote teaching in these conditions. An additional factor that may have increased their stress level was the need to prepare students for the final exam after grade 8 (which is usually perceived as an external measure of teaching effectiveness). Linking students' test scores to ratings of teaching quality may increase teachers' stress (von der Embse et al., 2015). Taking this into account there is a need to support subject teachers mainly in psychosocial competences that could enhance their self-efficacy and perceived self-effectiveness. This should be connected with promoting resilient coping strategies such as positivism, tolerance to frustration or locus of internal control (de Vera Garcia, Gabari Gambarte 2019).

Differences in the scope of support from peer teachers indicate that teachers from grades 1-3 received the most support. This relates to the general tendency for teachers of younger age groups to engage in more teamwork. It is worth noting that such cooperation would be particularly advisable within the framework of subject education for older age groups, where several teachers deliver sessions on different subjects in a given class. The lack of support in this area and the fact that individual teachers must create their own solutions causes methodical chaos, which has been identified by parents as the main barrier to their children's learning during the COVID-19 pandemic (Błaszczak, Knopik, & Maksymiuk, in press).

The necessity of implementing remote teaching during the pandemic means that more countries should introduce online teacher support programmes, which are well developed in countries where technology is already highly integrated into pedagogy (Paris, Boston, & Morris, 2015; Mercieca & Kelly, 2018). There is a strong need to learn from the first phase of the pandemic and design a contingency plan that includes a system of support that enables teachers to embrace new pedagogies and assume new functions beyond teaching in order to support students and their families. As the benefits of online peer support programmes are evidence based (e.g. Yildirim, 2019; Paris, Boston, & Morris, 2015; Mercieca & Kelly, 2018), these programmes should be implemented into teachers' education and professional practice on a regular basis.

Teachers are expected to prepare their students to live and work in a society of knowledge. To do this, difficult tasks – even emergency remote teaching – should be treated as challenges rather than threats. The experiences of teaching and learning during the pandemic should be collected and evaluated not only to document their historical importance, but also to help educators to navigate obstacles and solve problems in the future.

Conclusion

An important component of remote education is teachers' evaluation of its effectiveness. Teachers who assume from the very beginning that ERT is prone to failure will have a negative impact on the attitudes and motivation of students. This research identified predictors of teachers' evaluation of SEERT. It turned out that the three most important explanatory factors are: 1) GSE, understood as a generalised sense of one's agency; 2) social support from peers; and 3) level of digital competence. The need to react quickly to an unforeseen situation (of which there is likely to be more in our fast-changing world) requires more general resilience and help from others to work out common solutions, rather than hard IT competence. The results can be used to plan the path of teachers' skill development so as to strengthen their adaptive potential, allowing them to work effectively in new conditions.

The implications for educational practice are that: elements for building self-efficacy should be incorporated into teacher-training programmes; peer support models should be implemented in teacher education and professional development

practices (e.g. peer group mentoring programmes, cf. Pennanen, Heikkinen, & Tynjälä, 2018); and digital competency among teachers and trainees should be strengthened not only at the routine communication level, but also as a new paradigm for designing courses and addressing students' complex cognitive, social and emotional needs.

Limitations and further research

The study was carried out in the fourth and fifth week of the COVID-19 school closures in spring 2020. On the one hand, this might be considered as sufficient time for the shift to ERT to have been completed. But on the other hand, during this period teachers and learners were probably still adapting to the changes. It is likely that the implementation of a longitudinal paradigm with the variables being measured at two or three different stages of the school closure would allow for a finer-grained analysis of the methods, strategies and effectiveness of remote teaching.

One more limitation stems form the fact that the research has been based on self-reporting measures. In futur research more objective tools should be used. It might also be profitable to ask other school actors (students. School leaders and policy makers, parents) about their perception of teaching effectiveness of (emergency) remote teaching.

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Footnotes

[1] Polish teachers spend on average about four hours a day delivering face-to-face instruction to students.

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The Effect of Teaching with Anatomical Models in Science Education on Primary School Children's Understanding of Human Organs

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Abstract

Primary school students often do not have differentiated conceptions of human organs and organ systems. As understanding the inner structure of the human body is an elementary prerequisite for the development of health awareness, appropriate forms of teaching must be developed to modify students' fragmented preconceptions about the inside of their bodies into scientifically accurate concepts. Anatomical models are considered a medium to raise awareness of organs and their systemic integration; however, only a few studies have investigated their effectiveness in the context of primary school. This intervention study, therefore, examines the effect of anatomical models on the conceptions of inner organs in German primary school students (N = 45) in a pretest, posttest, and follow-up test design with anatomy teaching between pre- and posttests. Concepts were measured using students' drawings in two treatment groups (anatomical models versus anatomical illustrations). While in both treatment groups students' conceptions changed toward more scientific concepts, there was little difference in the changes between the two groups. There were even indications that the students of the control group showed more pronounced increases, for example, in long-term systemic integration of the organs. We discuss the reasons for this and furnish recommendations for effective teaching practices.

Keywords:

Conceptual Change, Models, Primary School, Science Education, Students' Drawings

Introduction

The ongoing COVID-19 pandemic has engendered anxieties and concerns among many children, decreasing their health-related quality of life and restricting their psychological well-being (Ravens-Sieberer et al., 2020). Children are now more vulnerable to adverse aspects of health, disease, respiratory failure, and ventilation compared to the time before the pandemic. Awareness about one's own body as well as health-promoting measures can

counteract health-related anxieties (Gaudion, 2000). Knowledge about their organs enables children to take responsibility for their own health and lifestyle. Accordingly, curricula of primary school general studies (Sachunterricht) in Germany require addressing one's own body, its nutrition and care, to develop health-promoting attitudes and behaviors (MSB NRW, 2021). Primary school children have only fragmentary concepts about internal processes and human organs (Óskarsdóttir, 2006; Piko & Bak, 2006). Considering their classroom and everyday experiences, they develop – within the scope of their possibilities – ideas about what happens inside them in the event of an illness (Gesellschaft für Didaktik des Sachunterrichts, 2013).

Student Conceptions

"Student conceptions" refer to the concepts students develop before, during, and after lessons (Möller, 2018). This term has not yet been fully clarified in the literature (Krumphals et al., 2020). Expressions such as everyday conceptions, prior experiences, prior knowledge, preconceptions, or misconceptions are often used in similar contexts, the latter indicating a contradiction between the students' conceptions and scientifically viable concepts (Möller, 2018). In the following, the terms preconceptions and student conceptions are used to refer to students' mental representations of human internal organs and organ systems. Whereas initially research centered on preconceptions, nowadays, research purview extends to conceptions generated during teaching processes in addition to postconceptions (Möller, 2018). Preconceptions arise from primary everyday experiences and expressions, common thought patterns, and information and opinions influencing the individual (Möller, 1999). These are significant for scientific learning because, on the one hand, they can interfere with learning pathways and scientific findings, while on the other hand, they are the starting point of learning (Duit, 1997).

The distinction between "deep structure" concepts and "current constructions" is relevant for learning contexts. While the former concepts are anchored strongly in form of convictions and are thus highly resistant to change, the latter concepts are developed spontaneously in a given situation (Hartinger & Murmann, 2018). As preconcepts are based upon everyday conceptions that are often acquired over many years, they tend to be more deeply rooted than novel concepts developed after a few lessons (Barke, 2006). Therefore, preconcepts have a high resistance to change and can rarely be altered radically through teaching (Adamina et al., 2018).

One strategy to transform the often scientifically questionable preconceptions of primary school children into scientific conceptions is to provoke a cognitive conflict within the student (Grimm et al., 2020). Students have to realize that they cannot explain observable phenomena (e.g., respiratory rate at different loads) with their previous concepts of human organs and organ systems. Such a conflict motivates them to follow the lessons and develop new thought patterns (Barke, 2006). For a conceptual change to take place, four conditions must be met (Posner et al., 1982): First, there must be dissatisfaction with existing conceptions (Posner et al., 1982), i.e., the student has realized, for example, that his or her perceptions about the respiratory system are not sufficient to explain the lifting of the chest during inhalation. Second, the new concept must be comprehensible (Posner et al., 1982), i.e., teaching methods and media used must be suitable for adequately grasping the content, e.g., the structure and function of the respiratory tract. Third, the new concept should appear plausible (Posner et al., 1982). In other words, realizing the large volume of the lung as along with its ability to change in volume, for example, should help understand the lifting of the chest during inhalation. Fourth, compatibility is pertinent to conceptual change (Posner et al., 1982). For instance, understanding the respiratory system is essential for comprehending the importance of the cardiovascular system. During the process of conceptual change, new information is integrated into existing knowledge structures by expanding, differentiating, or even abandoning existing concepts to add new content to the preconcepts and replace the latter with adequate concepts. The extent of the transformation is expressed by terms such as conceptual growth, addition, revision, emplacement, or enrichment (Möller, 2015).

There are still relatively few studies on anatomical preconceptions about the human body of children under the age of seven years (Bietenhard et al., 2018). However, already seven-year-olds have knowledge of several organs. When asked to draw their organs, primary school children frequently mention heart, brain, and stomach (Stiftung Haus der kleinen Forscher, 2016) or skeleton, components of the cardiovascular system, and the gastrointestinal tract. Other organs such as liver or lungs are hardly ever mentioned (Manokore & Reiss, 2005; Spägele & Flintjer, 2011). Third-grade pupils reported in an interview that they have already seen illustrations of the brain, but their interpretations were noted to vary to a great extent. For example, when seeing an illustration of the cerebral cortex, they recognized tubers, pipes, or bubbles. Moreover, students were found to be unaware of the fact that the color coding of blood vessels depending on the oxygen content of the blood (red/blue) or the colored representation of brain areas does not correspond to the actual color of the vessels or the brain (Vocilka, 2005). About half of the children starting school were observed to be familiar with the function of the heart, the muscles, and the stomach, whereby the function of the heart is linked to the externally perceptible effect of beating (Spägele & Flintjer, 2011). The representation

of the heart in children's and adolescents' drawings usually resembles a symbolic representation of the heart. Yet, it is not always clear whether children actually assume that this corresponds to the shape of the real organ or whether shapes of media representations are deliberately adopted. As 13- to 14-year-olds still prefer this form of representation, it can be assumed to be a deliberate symbolic representation (Gellert, 1962; Reiss & Tunnicliffe, 2001). On the whole, children are more familiar with organs that can be perceived directly or indirectly from the outside (e.g., heart, lungs) than those that cannot be felt (e.g., liver, kidneys). While primary school children can localize the position of the brain and the heart in the body relatively well, the position of the lung is often unknown (Óskarsdóttir, 2006). Spägele and Flintjer (2011) concluded that scientific perceptions are all the more developed the more direct and tangible they are in a child's environment. Inner processes or organs are hardly known and explained by deducing from outer to inner processes (Spägele & Flintjer, 2011). In children's minds, air, for example, is invisible, has no physical weight, and often only exists in a moving form as perceptible wind. From these perceptions, it can be concluded that there are no consistent ideas about the mechanism of respiration in the human body as well as the properties of air. This lack of conceptual knowledge has major consequences for other areas, such as the function of the lung (Spägele, 2008). An understanding of the systemic interrelationships between the organs is not fully developed neither in primary school (Óskarsdóttir, 2006) nor at the age of 15 (Stiftung Haus der kleinen Forscher, 2016). In general, only a few students are able to draw organ systems in a way that allows their classification as a system. Among them, the most frequently depicted are the digestive system and the respiratory tract (Reiss & Tunnicliffe, 2001). Likewise, understanding the blood circulation, including the path of the blood through the pulmonary circulation, is still difficult for students at lower secondary level (Riemeier et al., 2010). Even in other biological contexts, it can be observed that students face difficulties in linking concepts of different organization levels vertically (here: isolated organs and organ systems; Hammann, 2019).

Previous studies have confirmed that teaching human anatomy can develop primary school children's ideas about internal human organs toward more scientific ideas (e.g., Óskarsdóttir, 2006). However, it remains largely unclear which teaching methods or media give rise to this influence. One possible way to make new concepts easier to understand and more plausible for students is to use models (Posner et al., 1982).

Anatomical Models in Science Class

Models are central working and teaching aids both in natural sciences (Krüger et al., 2018) and in natural science teaching (Przywarra & Risch, 2019). On the one hand, they serve as media for conveying familiar content and, on the other hand, as tools for generating new knowledge (Krüger et al., 2018). The development of initial model conceptions of natural phenomena as well as becoming familiar with the interpretative character of models are therefore integral components of the basic science education (cf. Gesellschaft für Didaktik des Sachunterrichts, 2013). In contrast to the complexity of reality, a good model is characterized by the fact that it only depicts those essential characteristics for which it was created to gain knowledge of the scientific phenomenon or illustrate complex inter-relationships. Model selection should be both goal-oriented as well as situation- and addressee-oriented (Heitzmann, 2019). Through their characteristics, models enable children to recognize structural relationships and make it easier for them to learn challenging content in general studies (Hardy et al., 2004). In natural science lessons, models are typically employed as a medium for imparting knowledge. For example, a plastic structural model of a human body can be used as a teaching and learning tool to illustrate the difficult-to-access and hidden internal organs of the human body (Marika Haider, 2019; Stiftung Haus der kleinen Forscher, 2016). Furthermore, models have the potential to promote the development of transferable knowledge and long-term implementation of learning content as well as motivation (Marika Haider, 2019). In addition, students use models to help explain and articulate their understanding of scientific phenomena (Harrison & Treagust, 1993).

Even students' conceptual comprehension can be supported by a systematic use of models in the classroom (Dilber & Duzgun, 2008). Models achieve this by first creating dissatisfaction in children with their preconceptions and then providing an understandable and plausible explanation (Dilber & Duzgun, 2008). To achieve explanatory power, models used in the classroom should therefore be adapted to the background and living conditions of the students (Glynn et al., 1994). If this succeeds, non-viable preconceptions can be transformed into scientific concepts by using models in the classroom, as demonstrated by a control group study in primary schools general studies on electricity using models. Even lower-performing students benefit from the use of models (Michael Haider, 2010). Similarly, the studies by Möller et al. (2002) and Hardy et al. (2004) on the topic "swimming and sinking" in general studies at primary school show that the use of predetermined and student self-constructed forms of representation can stimulate a change of scientific concepts, because they help students abandon non-viable preconceptions.

However, models always represent a learning diversion, because they require the student to make a conclusion by finding resemblance of the model's

features with the original. If this is not successful, the model cannot contribute to students' understanding (Marika Haider, 2019). A plastic torso used in class is clearly different from the real human body – and not only in terms of material. Nevertheless, it offers many visual links to the real human body such that the position, size, and appearance of the organs are easier for children to understand (Stiftung Haus der kleinen Forscher, 2016). However, in addition to a possible lack of analogy, there is a risk that students understand models as a replica of the original, although models are basically a simplified representation of reality (Heitzmann, 2019). On the one hand, this bears the risk of simplifying scientific relationships (e.g., the systemic relationships of human internal organs), and on the other hand, there exists the problem of a poor expandability of knowledge acquired from the model (Marika Haider, 2019). To counteract misconceptions and develop an adequate understanding of models and the original system they represent, it is, therefore, necessary to address the differences between a model and the original in class (Meisert, 2014; Vocilka, 2005). Therefore, when using anatomical models in general studies, model criticism should be practiced with students to counteract an unreflective use of models in the sense of model competence.

That the use of anatomical models in teaching can be effective is known from medical education, in which the use of anatomical models has a long-standing tradition (Narang et al., 2021; Talairach-Vielmas, 2014). From studies in this context, it is known that three-dimensional anatomical models – whether plastic models (Smith et al., 2018) or digital three-dimensional models (Haque et al., 2021; Nicholson et al., 2006; Zilverschoon et al., 2021) – can have a greater learning effect than two-dimensional representations. However, there is hardly any control group study on the effectiveness of the use of anatomical models in the context of human biology topics in general studies at primary school. This study was conducted with the aim to investigate whether the use of anatomical models can stimulate a conceptual change related to the knowledge of organs and their correct position, systemic integration, and appearance.

Method

Sample Size and Study Design

Forty-five third-grade students (N_{female} = 26, N_{male} = 19, average age = 8.7 years) from an elementary school in North Rhine-Westphalia, Germany, participated in this study, which was conducted in a pretest, posttest, and follow-up test design. The student participants were divided into two treatment groups (hereinafter referred to as model group, MG, N_{MG} = 24 and *control group*, CG, N_{CG} = 21). Both groups participated in five teaching units (seven hours in total) on internal organs of the human body between the pre- and posttests. Neither of them had been taught about the subject before. While the MG was taught using anatomical models, the CG was taught without haptic models but with two-dimensional illustrations of the internal organs. In the first teaching unit (one lesson), both groups dealt with the location of the internal organs using an anatomical plastic torso (MG) and a poster showing the position of the internal organs (CG). In the second teaching unit (two lessons), the human heart and lungs were discussed, with MG building a functional model of the lungs while CG worked out the function of the lungs with the help of illustrations. The third teaching unit (one lesson) linked the respiratory system with the cardiovascular system. In this lesson, the MG performed a role-play on blood circulation by assigning different roles to the students (e.g., heart and oxygen), whereas the students in the CG watched a two-dimensional explanatory film. In the penultimate teaching unit (two lessons), both treatment groups dealt with the human digestive tract exploiting the method of learning stations. While the MG executed some model experiments (for example, simulating the esophagus when pushing a marble through a garden hose), the CG worked with illustrated worksheets. In the final teaching unit (one lesson), both groups solved a quiz on the internal organs of the human body for revision. Pre- and posttests were directly implemented at the beginning of the first and at the end of the last lesson, respectively, with the follow-up test after four weeks.

Measuring Instrument

As it is not possible to directly measure students' conceptions (Adamina, 2008), students' drawings of human organs were used to capture their conceptions in a pretest, posttest, and follow-up-test. The use of children's drawings has already proven successful in various studies to measure thoughts and concepts about human anatomy (Bietenhard et al., 2018; Piko & Bak, 2006; Ranaweera & Montplaisir, 2010). In this study, the students were asked to draw the internal organs on a blank paper showing only the outline of the human torso. While this outline was primarily intended to help students with less artistic talent, in particular, to concentrate on the internal organs (Óskarsdóttir et al., 2011), it also gave us an objective frame of reference to evaluate the correct location of the individual organs. Drawings are not just a time-efficient way to measure concepts, they are interesting, motivate students, and enable international comparability as they do not depend on written or spoken language (Reiss & Tunnicliffe, 2001). Nevertheless, it makes sense to give students an additional opportunity to express themselves in writing. As this can facilitate the analysis of children's drawings (Adamina, 2008), we included some blank lines in the measuring instrument (Figure 1).

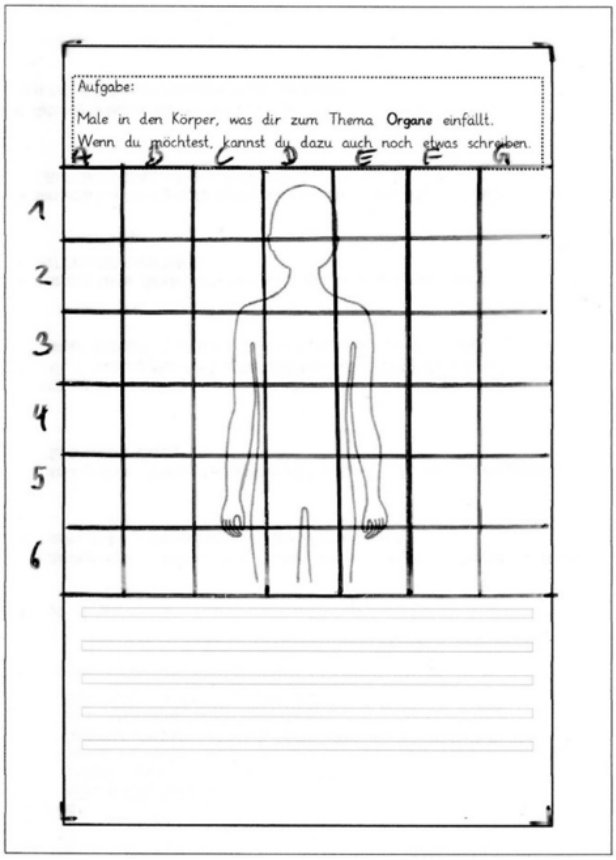
Data Analysis

All statistical analyses were performed using Statistical Package for the Social Sciences (SPSS) 28. Because students were free to draw any organs they liked, three experts in biology didactics developed an evaluation key to ensure the objectivity of the evaluation and avoid the risk of assessing artistic quality (Bietenhard et al., 2018; Reiss & Tunnicliffe, 2001). The key was initially divided into four main categories, namely, organ presence, organ position, systemic integration, and realism. Owing to spontaneously observed similarities between the drawings and the representations used in the treatments, the additional main category spontaneous observations was introduced later. Each main category was divided into subcategories, in the case of organ presence, organ position, and realism represented by several organs (heart, lung, stomach, etc.). The main category systemic integration was subdivided into the subcategories cardiovascular system, respiratory system, and digestive system. The main category spontaneous observations comprised the subcategories covered half similarity, dark spot similarity, vascular connection similarity, box-shaped similarity, and striking lines similarity. These are the conspicuous features on the representations used in the treatment: The human model torso used in the MG showed a half-covered intestine and a dark spot where the large intestine was incised, whereas the poster that was used in the CG showed the small intestine as wavy lines and the large intestine as box shaped. The poster also showed the heart with attachments of blood vessels. Each organ (or organ system in case of the main category systemic integration) in a main category was coded with two (organ presence: organ present/absent) or three variable expressions (organ position: correct position/wrong position/absent; realism: more realistic/less realistic (symbolic)/absent; spontaneous observations: similarity/dissimilarity/absent). To ensure objectivity in determining the organ positions, a grid was placed on the outline of the human torso during evaluation (Figure 1). The main category systemic integration was coded as correct systemic integration/incorrect systemic integration/missing systemic integration. A correct systemic integration was coded in case one or more correct connections between organs of an organ system were present in the drawing (e.g., if the stomach was connected to the intestine in the correct order).

Figure 1 depicts the measuring instrument, and the grid placed over it for ascertaining the position of the organs. For example, if the heart was drawn in D3, this was considered the correct position. The top of the worksheet displays task for the students (translated from German into English: Draw into the body whatever comes to your mind on the subject of organs. If you like, you can also write something about it.)

Figure 1

Measuring Instrument and the Grid Placed Over it for Determining the Position of the Organs



As the students were completely free in drawing, it was necessary to empirically verify the objectivity of the evaluation by calculating an inter-rater agreement (Moosbrugger & Kelava, 2020). For this purpose, a second rater evaluated 44.4% of the sample. Because our dataset consisted of categorical data, Cohen's kappa (κ) was used to calculate interrater reliability (Wirtz & Kutschmann, 2007). A value of κ < .00 is regarded as poor, .00–.20 as slight, .21–.40 as fair, .41–.60 as moderate, .61–.80 as substantial, and .81–1.00 as almost perfect (Landis & Koch, 1977). Because of inaccuracies in the first version of the evaluation key, the main categories systemic integration of the organs and representation of the whole intestine were again completely evaluated by the second rater and an additional 44.4% by a third rater. We report the final k for each measured characteristic in the results. Our data were categorical because of the fact that there was no theoretical reason to combine the subcategories into one scale, and the frequency of undrawn (missing) organs was found highly relevant for assessing changes in students' conceptions. Thus, the frequencies and changes in the frequency of each individual organ drawing between the measurement times were evaluated. Thereafter, we calculated the changes in frequency between (1) pre- and posttests and (2) pretest and follow-up test for each subcategory (e.g., for the frequency of correctly or incorrectly positioned hearts) as follows: For the main category

organ presence, a change from absent to present was coded as appearance, a change from present to absent as disappearance and in all other cases as unchanged. In the case of the main category organ position, changes from "missing" or a wrong position in the pretest to a correct position in the posttest or follow-up test were coded as correction. Changes to a wrong position in the second test were coded as falsification, unchanged variable characteristics as unchanged, and the remainder as unidentifiable. The same procedure was used to evaluate the changes in the main categories systemic integration, realism, and spontaneous observations. We subsequently used these changes in a 3 x 2 and 4 x 2 contingency table comparison where "2" represents the two treatment groups and "3" and "4" are the number of variable characteristics. As there were one or more expected values of five or less in all contingency tables (Comiskey et al., 2014), Fisher's exact test was used to detect relationships of the conceptual changes between the treatment groups. Cramer's V (*V*) is given as a measure of effect size (small effect *V* = .1, medium effect *V* = .3, large effect *V* = .5; Cohen, 1988).

Results

Inter-rater reliability: We used kappa statistics to calculate the inter-rater reliability for each organ within each construct and time of measurement (see Table 1). Only eight of 105 calculations showed a fair agreement with Cohen´s κ between 0.27 and 0.40. In all the other cases, Cohen´s k ranged between 0.41 and 1.00, indicating a moderate-to-perfect agreement (Landis & Koch, 1977). In cases where one of the two variables used to calculate Cohen´s κ was a constant, the percentage of agreement was calculated with high values between 90 and 100.

Table 1

Cohen´s k Coefficient (N = 20) or, in Cases Where One of the Two Variables Used to Calculate Cohen´s k was a Constant, the Percentage of Agreement

Construct	Organ	Pretest	Posttest	Follow-up test
Organ presence	Heart	1.000	constant (100)	constant (100)
	Lung	.857	1.000	.773
	Stomach	.886	.886	.798
	Liver	.444	.528	.700
	Esophagus	.694	.694	.400
	Trachea	.444	.875	.612
	Intestine (whole)	.765	.857	.857
	Small intestine	constant (95)	.432	.612
	Large intestine	.643	.432	.600
	Brain	.900	1.000	1.000
	Blood vessels	.783	.900	.792
Organ position	Heart	.831	.692	.348
	Lung	.733	.394	.324
	Stomach	.431	.569	.649
	Liver	.459	.396	.442
	Esophagus	.450	.694	.447
	Trachea	.351	.610	.409
	Intestine (whole)	.556	.814	.583
	Small intestine	constant (90)	.423	.396
	Large intestine	.643	.423	.435
	Brain	.809	1.000	1.000
Systemic integration	Cardiovascular system	.902	.912	.906
	Respiratory system	1.000	.840	1.000
	Digestive system	.593	.551	.535
Realism	Heart	.524	.524	.700
	Lung	.857	.573	.462
	Lung details	.864	1.000	.835
	Esophagus	.724	.614	.400
	Brain	.900	.922	1.000
	Intestine (whole)	.672	.764	.665
Spontaneous observations	"Covered half" similarity	.765	.822	.725
	"Dark spot" similarity	.765	.780	.857
	"Vascular connection" similarity	.437	.266	.588
	"Box-shaped" similarity	.765	.837	.769
	"Striking lines" similarity	.765	.435	.612

Organ presence: The relative frequency of the organs drawn by both treatment groups is shown in Table 2. The heart, the brain, and the esophagus, in particular, were frequently drawn by both groups at the time of the pretest. The lungs and the stomach were more common in the CG, while the intestine was drawn more often in the MG. None of the groups differentiated between small and large intestine in their pretest drawings. In the posttest and follow-up test, not only did the students draw most organs more frequently, but they also drew a more detailed intestine by differentiating between the small and large intestine.

Table 3 shows the changes in the relative frequency of the organs from (1) pre- to posttest and (2) pretest to follow-up test taking into account the presence and absence of the organs. Fisher's exact test (p) and Cramér's V (V) are reported to determine relationships between group affiliation and changes in the organs' presence This table should be interpreted as follows: 8.3% of the MG drew a heart in the posttest without a heart being present in their pretest drawing. None of the students reduced the heart from their drawing from pre- to posttest. Consequently, 91.7% showed no change in the presence or absence of a heart. Taking into account the changes between the pre- and posttests, Fisher's exact test only showed one relationship to the treatment. Results showed a significant relationship between the treatment and the change in the presence of the liver with a more frequent occurrence of the organ in the MG ($p \leq .01$, $V = .466$). In the long run, however, CG seemed to have increased the incidence of trachea ($p \leq .001$, V = .536), small intestine ($p \leq .05$, $V = .339$), large intestine ($p \leq .01$, $V = .429$), and blood vessels ($p \leq .05$, $V = .419$) more often in comparison to the MG. Nevertheless, it must be taken into account that some students who drew a certain organ in the pretest no longer did so at the later measurement points, as can be clearly seen when looking at the blood vessels in the pretest/follow-up test, for example.

Organ position: The percentage of correctly and incorrectly positioned organs in the pretest, posttest, and follow-up test is shown in Table 4. This table should be interpreted as follows: 66.7% of the MG drew a heart at the correct position, whereas 25.0%

Table 2

Relative Frequency of the Organs Drawn of the MG and the CG for Each Time of Measurement

Organ	Pretest		Posttest		Follow-up test	
	MG	CG	MG	CG	MG	CG
Heart	91.7	90.5	100.0	100.0	91.7	95.2
Lung	29.2	42.9	91.7	90.5	79.2	85.7
Stomach	37.5	42.9	83.3	47.6	58.3	33.3
Liver	0.0	14.3	58.3	23.8	45.8	28.6
Esophagus	50.0	57.1	50.0	71.4	33.3	61.9
Trachea	25.0	28.6	50.0	71.4	4.2	61.9
Intestine (whole)	54.2	38.1	87.5	66.7	79.2	76.2
Small intestine	4.2	0.0	62.5	66.7	41.7	71.4
Large intestine	8.3	0.0	58.3	66.7	41.7	76.2
Brain	45.8	76.2	83.3	71.4	87.5	81.0
Blood vessels	33.3	23.8	45.8	42.9	41.7	42.9

Table 3

Percentage of Change in the Presence of the Organs (Presence/Absence) Between (1) Pre- and Posttests and (2) Pretest and Follow-up Test for the MG and CG

Organ	Pre-/Posttest			Pretest/Follow-up test		
	MG	CG	*p (V)*	MG	CG	*p (V)*
Heart	8.3/0.0	9.5/0.0	1.000	4.2/4.2	9.5/4.8	.791
Lung	62.5/0.0	52.4/4.8	.643	62.6/12.5	47.6/4.8	.289
Stomach	54.2/8.3	19.0/14.3	.061	37.5/16.7	19.0/28.6	.368
Liver	58.3/0.0	14.3/4.8	≤.01 (.466)	45.8/0.0	19.0/4.8	.084
Esophagus	33.3/33.3	23.8/9.5	.062	8.3/25.0	19.0/14.3	.543
Trachea	29.2/4.2	47.6/4.8	.476	0.0/20.8	42.9/9.5	≤.001 (.536)
Intestine (whole)	41.7/8.3	33.3/4.8	.727	33.3/8.3	38.1/0.0	.596
Small intestine	58.3/0.0	66.7/0.0	.759	37.5/0.0	71.4/0.0	≤.05 (.339)
Large intestine	50.0/0.0	66.7/0.0	.366	33.3/0.0	76.2/0.0	≤.01 (.429)
Brain	45.8/8.3	14.3/19.0	.074	50.0/8.3	19.0/14.3	.117
Blood vessels	29.2/16.7	38.1/19.0	.728	16.7/8.3	42.9/23.8	≤.05 (.419)

positioned it incorrectly. As a result, 8.3% of the MG did not draw a heart in the pretest. Around 50% to three quarters of both groups chose a correct position for the heart, brain, and esophagus. As a consequence of the low frequency in the pretest (see Table 2), only a few students positioned the small and large intestine correctly. For almost all organs, it can be observed that their positions became more correct from the pre- to the posttest.

Table 5 shows the changes in the correctness of the organ positions between (1) pre- and posttests and (2) pretest and follow-up test. Fisher's exact test (p) and Cramér's V (*V*) are reported to detect relationships between group affiliation and changes in the correctness. The table should be interpreted as follows: 58.3 % of the MG changed the position of the stomach from "missing" or an incorrect position in the pretest to a correct position in the posttest. None of the students changed it to a wrong position and 33.3% did not change the position of the stomach at all. The remainder, 8.4%, changed from a correct or incorrect position to "missing." Table 5 shows that a relationship with the treatment was found only in case of the liver ($p \leq .01$, $V = .466$). The students of the MG improved their positioning of the organ more noticeably than the students of the CG. The latter showed a stronger increase in the positioning of the trachea ($p \leq .01$, $V = .536$) as well as the small ($p \leq .05$, $V = .339$) and the large intestine ($p \leq .01$, $V = .429$) in the follow-up test.

Systemic integration of the organs: As shown in Table 6, there is only a relatively small number of students who connected the heart with blood vessels or the

Table 4

Relative Frequency of the Organs in the Correct and the Incorrect (Correct/Wrong) Positions in the Drawings of the MG and the CG at all Measurement Times

Organ	Pretest		Posttest		Follow-up test	
	MG	CG	MG	CG	MG	CG
Heart	66.7/25.0	57.1/33.3	87.5/12.5	71.4/28.6	87.5/4.2	81.0/14.3
Lung	16.7/12.5	33.3/9.5	79.2/12.5	71.4/19.0	70.8/8.3	76.2/9.5
Stomach	33.3/4.2	38.1/4.8	83.3/0.0	47.6/0.0	54.2/4.2	28.6/4.8
Liver	0.0/0.0	4.8/9.5	41.7/16.7	9.5/14.3	20.8/25.0	23.8/4.8
Esophagus	41.7/8.3	42.9/14.3	45.8/4.2	71.4/0.0	33.3/0.0	57.1/4.8
Trachea	25.0/0.0	23.8/4.8	50.0/0.0	71.4/0.0	4.2/0.0	52.4/9.5
Intestine (whole)	45.8/8.3	23.8/14.3	79.2/8.3	47.6/19.0	58.3/20.8	57.1/19.0
Small intestine	4.2/0.0	0.0/0.0	62.5/0.0	66.7/0.0	41.7/0.0	71.4/0.0
Large intestine	8.3/0.0	0.0/0.0	58.3/0.0	66.7/0.0	41.7/0.0	76.2/0.0
Brain	45.8/0.0	76.2/0.0	83.3/0.0	71.4/0.0	87.5/0.0	81.0/0.0

Table 5

Percentage of Changes (Correction/Falsification/Unchanged) in the Correctness of Organ Positions Between (1) Pre- and Posttests and (2) Pretest and Follow-up Test Shown for the MG and the CG

Changes	Organ	MG	CG	p (V)
Pre-/Posttest	Heart	29.2/12.5/58.3	28.6/19.0/52.4	.917
	Lung	66.7/12.5/20.8	47.6/14.3/33.3	.471
	Stomach	58.3/0.0/33.3	23.8/0.0/61.9	.070.
	Liver	41.7/16.7/41.7	9.5/4.8/81.0	≤.01 (.466)
	Esophagus	29.2/4.2/33.3	33.3/0.0/57.1	.130
	Trachea	29.2/0.0/66.7	47.6/0.0/47.6	.476
	Intestine (whole)	41.7/8.3/41.7	33.3/19.0/42.9	.725
	Small intestine	58.3/0.0/41.7	66.7/0.0/33.3	.759
	Large intestine	50.0/0.0/50.0	66.7/0.0/33.3	.366
	Brain	45.8/0.0/45.8	14.3/0.0/66.7	.074
Pre-/Follow-up test	Heart	29.2/4.2/62.5	33.3/4.8/57.1	.936
	Lung	62.5/8.3/16.7	47.6/4.8/42.9	.287
	Stomach	33.3/4.2/45.8	19.0/4.8/47.6	.699
	Liver	20.8/25.0/54.2	23.8/0.0/71.4	.051
	Esophagus	8.3/0.0/66.7	33.3/4.8/47.6	.106
	Trachea	0.0/0.0/79.2	33.3/9.5/47.6	≤.01 (.536)
	Intestine (whole)	25.0/16.7/50.0	47.6/14.3/38.1	.336
	Small intestine	37.5/0.0/62.5	71.4/0.0/28.6	≤.05 (.339)
	Large intestine	33.3/0.0/66.7	76.2/0.0/23.8	≤.01 (.429)
	Brain	50.0/0.0/41.7	19.0/0.0/66.7	.117

lungs with the trachea in the pretest. The table should be interpreted as follows: 29.2% of the students in MG drew a heart connected to blood vessels (= correct systemic integration), 4.2% drew a heart separated from blood vessels (= wrong systemic integration). The remaining 66.6% did not draw a heart or blood vessels. Neither the rudiments of a cardiovascular system nor a respiratory system is, therefore, clearly recognizable in most drawings. However, about half of the sample connected components of the digestive tract with each other in their pretest drawings. There was a short-term increase in systemic drawing from pre- to posttest for the cardiovascular and the respiratory systems. The correct systemic integration seemed to be more stable in the CG than in the MG in the long term (see Table 6).

Table 7 provides detailed information about the improvements and deteriorations in the systemic integration. Fisher's exact test (p) and Cramér's V (V) are reported to detect relationships between the group affiliation and the change in the systemic integration. The table should be interpreted as follows: 25.0% of the MG changed their drawing of a heart to a more systemic integration, 12.5% to a less systemic integration, and 50.0 % did not change the systemic integration at all (and the absence of the organ) from pre- to posttest. The remaining 12.5% could not be classified as increase or decrease because of a missing heart in the posttest. No significant relationship was found between the treatments and the change in the systemic drawing of the digestive tract from pre- to posttest or from pretest to follow-up test. However, there were significant relationships in the pretest–follow-up changes in the systemic integration of the heart ($p \leq .01$, $V = .536$) and in the pretest–posttest ($p \leq .001$, $V = .571$) as well as pretest–follow-up changes in the systemic integration of the lungs ($p \leq .001$, $V = .700$). All cases had a large effect size with the CG showing a more pronounced increase in the systemic integration than the MG.

Realism of the drawing: The realism of the students' drawings is reported in Table 8. This table should be interpreted as follows: 4.2% of the MG drew a heart in the approximately realistic form, whereas 87.5% drew a less realistic (often symbolic) heart. The remaining 8.3% did not draw a heart in the pretest. In the MG, there was an increase in the frequency of realistic drawings from pre- to posttest and pretest to follow-up test for all organs except the esophagus. The frequency of realistic drawings in the MG was already high in the pretest, remained constant in the posttest, and decreased in the follow-up test.

Table 6

Relative Frequency of the Systemic Integration (Correct/Wrong Systemic Integration) of the Cardiovascular, Respiratory, and Digestive System for the MG and CG at All Times of Measurement

System	Pretest		Posttest		Follow-up test	
	MG	CG	MG	CG	MG	CG
Cardiovascular system	29.2/4.2	23.8/19.0	45.8/12.5	42.9/4.8	20.8/16.7	42.9/0.0
Respiratory system	16.7/8.3	0.0/0.0	29.2/12.5	61.9/14.3	4.2/16.7	61.9/4.8
Digestive system	54.2/8.3	33.3/9.5	50.0/29.2	33.3/23.8	37.5/20.8	14.3/38.1

Table 7

Percentage of Changes (More Systemic/Less Systemic/No Changes) in the Relative Frequency of the Systemic Integration of the Cardiovascular, Respiratory, and Digestive System Between (1) Pre- and Posttests and (2) Pretest and Follow-up Test for the MG and CG

Changes	Organ	MG	CG	*p (V)*
Pre-/Posttest	Cardiovascular system	25.0/12.5/50.0	33.3/4.8/38.1	.572
	Respiratory system	12.5/8.3/75.0	61.9/14.3/23.8	≤ 0.001 (.571)
	Digestive system	20.8/25.0/41.7	19.0/23.8/47.6	1.000
Pretest/ Follow-up test	Cardiovascular system	8.3/16.7/62.5	38.1/0.0/28.6	≤ 0.01 (.536)
	Respiratory system	0.0/12.5/70.8	61.9/4.8/33.3	≤ 0.001 (.700)
	Digestive system	12.5/20.8/50.0	9.5/33.3/47.6	.794

Table 8

Relative Frequency of More Realistic and Less Realistic (More Realistic/Less Realistic) Drawings for the MG and CG at All Times of Measurement

Organ	Pretest		Posttest		Follow-up test	
	MG	CG	MG	CG	MG	CG
Heart	4.2/87.5	0.0/90.5	50.0/50.0	61.9/38.1	29.2/62.5	52.4/42.9
Lung	8.3/20.8	0.0/42.9	33.3/58.3	47.6/42.9	12.5/66.7	28.6/57.1
Lung details	16.7/16.7	28.6/14.3	91.7/0.0	90.5/0.0	70.8/4.2	85.7/0.0
Esophagus	50.0/0.0	47.6/9.5	50.0/0.0	66.7/4.8	29.2/8.3	61.9/0.0
Brain	12.5/33.3	4.8/71.4	16.7/66.7	23.8/47.6	29.2/58.3	19.0/61.9
Intestine (whole)	29.2/25.0	4.8/33.3	41.7/45.8	9.5/57.1	37.5/41.7	14.3/61.9

Table 9 shows the development of the reality content from pre- to posttest and pretest to follow-up test. Fisher's exact test (*p*) and Cramér's V (*V*) are reported to detect relationships between the group affiliation and the change in realism. It should be interpreted as follows: 47.6% of the CG changed the realism of their lung drawing from "symbolic" or "missing" in the pretest to "realistic" in the posttest. Furthermore, 23.8% changed it from "realistic" or "missing" to a symbolic drawing, and 23.8% did not change realism (or absence) of their lung drawing. The increase or decrease of realism was not assessable for the remaining 4.8% because of the absence of lungs in their posttest drawings. A high percentage of students in both treatment groups increased the realism of their drawings. For some organs (e.g., the lungs and the brain in the MG), there was also a considerable increase in unrealistic, symbolic drawings. This does not mean that the students were getting worse overall, but it was because of the overall increase in the number of organs drawn after the treatment (see Table 2). A significant relation of group affiliation and changes in realism was shown only in the case of the brain with an increase of more symbolic drawings in the MG and of more realistic drawings in the CG ($p \leq .05$, $V = .424$) from pre- to posttest.

Spontaneous observations: A systematic examination of the initially randomly observed similarities between the drawings and the model torso or poster led to the results summarized in Table 10. This table should be interpreted as follows: None of the pretest drawings of the MG showed similarities to the model torso in the sense of a half-covered intestine, while 54.2% of the drawings showed an intestine without this similarity. The remainder 45.8% did not draw an intestine in the pretest. While no particular similarities between the drawings and the torso or poster were noticeable in the pretest, this changed in the posttest and remained until the follow-up test. About half of the drawings of the MG showed similarities to the intestine of the model torso used in their treatment. This means they drew an intestine that was half covered, as shown by the torso. There was no resemblance of this kind in the CG. In another striking feature (the incised large intestine, which looked like a dark spot in the model torso), there were only a few drawings of the MG that resembled the model torso in the posttest. However, it is still noticeable that in the posttest and follow-up test of the CG, conspicuous features of the poster used in this treatment frequently appeared in the drawings, that were not present in their pretest and that were not (in case of the box-shaped larger intestine and in case of striking lines in the smaller intestine) or considerably less present (in case of striking vascular connections at the heart) in the MG's drawings.

Table 9

Percentage Change in Realism (More Realistic/Less Realistic/Unchanged) of Organ Positions Between (1) Pre- and Posttests and (2) Pretest and Follow-up Test in the MG and CG

Changes	Organ	MG	CG	*p (V)*
Pre-/Posttest	Heart	50.0/8.3/41.7	61.9/4.8/33.3	.727
	Lung	33.3/41.7/25.0	47.6/23.8/23.8	.453
	Lunge details	79.2/0.0/16.7	61.9/0.0/33.3	.498
	Esophagus	33.3/0.0/33.3	28.6/4.8/57.1	.120
	Brain	8.3/45.8/37.5	23.8/9.5/47.6	≤.05 (.424)
	Intestine (whole)	29.2/33.3/29.2	9.5/28.6/57.1	.209
Pretest/ Follow-up test	Heart	25.0/4.2/66.7	52.4/4.8/38.1	.182
	Lung	8.3/54.2/25.0	28.6/33.3/33.3	.221
	Lunge details	66.7/0.0/20.8	57.1/0.0/38.1	.348
	Esophagus	12.5/8.3/54.2	28.6/0.0/57.1	.317
	Brain	20.8/41.7/29.2	14.3/14.3/57.1	.129
	Intestine (whole)	25.0/37.5/29.2	9.5/33.3/57.1	.149

Table 10

Relative Frequencies of Similarities (Similarity/Dissimilarity) to the Model Torso and to the Poster Used in the Treatment

Resemblance to	Pretest		Posttest		Follow-up test	
	MG	CG	MG	CG	MG	CG
the intestine on the torso (covered half)	0.0/54.2	0.0/38.1	37.5/50.0	0.0/66.7	29.2/50.0	0.0/76.2
the large intestine on the torso (dark spot)	0.0/54.2	0.0/38.1	8.3/79.2	0.0/66.7	0.0/79.2	0.0/76.2
the large intestine on the poster (box-shaped)	0.0/54.2	0.0/38.1	0.0/91.7	47.6/19.0	0.0/91.7	61.9/14.3
the small intestine on the poster (striking lines)	0.0/54.2	0.0/38.1	16.7/70.8	42.9/23.8	20.8/58.3	28.6/47.6
the heart on the poster (vascular connections)	0.0/91.7	0.0/90.5	0.0/91.7	57.1/42.9	0.0/91.7	61.9/33.3

The results of Fisher's exact test comparing the changes of similarities from (1) pre- to posttest and (2) pretest to follow-up test in both treatment groups confirm dependencies with the treatment (see Table 11). In the MG, a more substantial increase in similarities to the model corpus can be observed compared to the CG, both in the posttest and the follow-up test. On the other hand, in the drawings of the CG, features of the poster used in the treatment accumulate.

Discussion

The results of this study showed that already in the pretest about one-third to one-half of the students were able to draw some internal organs and position them correctly in the body. In line with previous studies, many students drew the heart, the brain, and individual organs of the digestive system. Internal organs without a directly noticeable external effect, such as the liver, were rarely present (Manokore & Reiss, 2005; Reiss & Tunnicliffe, 2001; Spägele & Flintjer, 2011; Stiftung Haus der kleinen Forscher, 2016). The fact that no organs of the reproductive system were drawn may be related to missing concepts or a taboo, as mentioned by Prokop and Fancovicová (2006). As the primary school students in this study have not yet had lessons on the inner organs, the results showed the relevance of their everyday experiences for their preconceptions. Accordingly, it is not surprising that students make relatively few systemic connections of the heart in the pretest as there are no externally visible connections of the cardiovascular system. At this point in time, the elements of the respiratory system are also barely connected. The less scientific ideas of many students were also indicated by the often symbolic representation of the internal organs such as the heart, in line with previous studies (Reiss & Tunnicliffe, 2001).

This can be explained by the fact that students obviously learn about organ systems at different ages (Bartoszeck et al., 2011; Reiss & Tunnicliffe, 2001). It seems as if they first learn that the human body consists of individual organs, then recognize their position, and only later understand that the organs are interconnected in order to form functional organ systems (Reiss & Tunnicliffe, 2001). Surprisingly, about one-third (CG) to one-half (MG) of the students connect at least individual organs of the digestive system (often esophagus and stomach). This finding is in line with the data of Garcia-Barros et al. (2011), who reported more adequate conceptions of four- to seven-year-old children about their digestive system than about their respiratory system. Possibly, kids ask themselves at a young age what happens to their food after the chewing and swallowing process. Also, it is more likely that they have experienced "tummy ache" more often than breathing problems at this young age level, which brings the stomach to their awareness. Another reason why parts of the digestive system might be more dominant in their conceptual thinking than the respiratory system could be that air is mostly perceived as invisible and therefore non-existent (Spägele, 2008). However, the drawings of the digestive system in this study are not very detailed in the pretest, as shown by the low frequency of a differentiated small and large intestine.

For most organs, as well as the digestive system, there is an increase in the frequency of drawn organs as well as correctly positioned organs in both treatment groups showing a positive effect of both treatments. However, this effect is more noticeable in the CG than in the MG, especially for the organs of the digestive system and trachea and in the long term. Furthermore, while some students improved the systemic integration of organs in the posttest, others deteriorated. This was the case for the intestinal system in both treatment groups. In the CG, however, a clear short-term (pre–post) as well as long-term (pre–follow-up) improvement in systemic integration of the respiratory system was observed. The observations of Carvalho et al. (2004) could provide an explanation for the better performance of the CG. They assumed that the absence of teaching nutrient absorption and the inadequately illustrated pathway of food from the stomach via the intestine to the anus in teaching material can give rise to confusion at the intestinal

Table 11

Percentage Changes in Similarities with the Model Torso and the Poster (similar/less similar/unchanged) from pretest to posttest or from pretest to follow-up test in the model group (MG) and the control group CG

Changes	Resemblance to	MG	CG	*p (V)*
Pre-/Posttest	the intestine on the torso (covered half)	37.5/37.5/16.7	0.0/33.3/61.9	≤.001 (.562)
	the large intestine on the torso (dark spot)	8.3/41.7/41.7	0.0/33.3/61.9	.505
	the large intestine on the poster (box-shaped)	8.3/37.5/45.8	47.6/4.8/42.9	≤.01 (.519)
	the small intestine on the poster (striking lines)	16.7/37.5/37.5	42.9/9.5/42.9	.071
	the heart on the poster (vascular connections)	8.3/8.3/83.3	57.1/4.8/38.1	≤.001 (.527)
Pre-/Follow-up test	the intestine on the torso (covered half)	29.2/25.0/37.5	0.0/38.1/61.9	≤.05 (.468)
	the large intestine on the torso (dark spot)	0.0/33.3/58.3	0.0/38.1/61.9	.596
	the large intestine on the poster (box-shaped)	4.2/33.3/54.2	61.9/4.8/33.3	≤.001 (.657)
	the small intestine on the poster (striking lines)	20.8/25.0/45.8	28.6/23.8/47.6	.757
	the heart on the poster (vascular connections)	0.00/4.2/91.7	61.9/4.8/28.6	≤.001 (.700)

level. Both the human torso and the poster used in our treatments include the digestive and the respiratory systems. In both media, the continuous path of the digestive system may remain unclear because of the way the extended intestine is represented. Especially in the three-dimensional model torso, the path of the food through the digestive system and the path of air to the respiratory system can hardly be traced. In particular, the path of the air from the mouth to the lungs is probably more apparent in the two-dimensional poster. However, this does not automatically mean a higher increase in realistic representations of the organs in the CG. Apart from the exclusively realistic depiction of the two lungs in both treatments in the short term (pre–post) and the long term (pre–follow-up), some students changed their drawings of the other organs to a more realistic depiction in both the short and long terms, while unrealistic drawings occurred in others. A significant relationship between change in realism and treatment group exists only in case of the brain, with a stronger increase in realism in the CG and a stronger increase in unrealistic, symbolic drawings in the MG. This is probably just a consequence of the plastic torso used in the MG which, in contrast to the poster of the control group, did not include a brain. This is a limitation of the present study that needs to be optimized in future studies. It would be interesting to see if there would still be more realistic drawings in the CG. This would be an indication that the two-dimensional poster probably has a more focusing, attention-grabbing effect, as this type of representation may link better to representations the students are familiar with. This kind of connection with prior knowledge is highly relevant for gaining the attention of primary school children (Shin & Shin, 2016). However, both, the models in the MG and the two-dimensional representations used in the CG, seem to have caught the students' attention. This was evidenced in the increase in similarities of the students' drawings with the model torso in the MG as well as with the poster in the CG. Such similarities of student drawings to models used in treatment were also observed by Copolo and Hounshell (1995) for high school chemistry classes. The unreflective adoption of models' unwanted accessories into students' conceptual thinking, e.g., drawing the semi-concealed intestine of the model torso or the rectangular intestine of the poster are from a scientific point of view undesirable effects. This finding also indicates that the ability to draw organs does not necessarily require knowledge about their functions—nor a correct inner positioning of the organs (Prokop & Fancovicová, 2006). This result is of relevance for practical anatomy teaching in primary schools as it emphasizes the need to support students in understanding external representations—such as physical models (Ingham & Gilbert, 1991) or graphical illustrations (Scaife & Rogers, 1996)—as analogies and not as mere replicas. The level of understanding an analogy and the effective integration of the information conveyed by an analogy correlates highly with the level of conceptual understanding of students (Mason, 1994). It should be supported by the teacher using supportive cues, prompting questions, or elaborations of the anatomical analogy (Richland et al., 2007) to make the analogy explicit to the students and prevent misleading students' learning process (Duit et al., 2001).

Potential differences in external representations (children's drawings) and internal mental representations of human organs are not just a limitation of this study but also a limitation in terms of measuring students´ conceptions of internal organs in general, as mental models only exist in the mind of the subject (Buckley & Boulter, 2000), and it is therefore questionable whether it is possible to externally measure them. In line with other studies (Óskarsdóttir, 2006; Reiss & Tunnicliffe, 2001; Riemeier et al., 2010), we used (two-dimensional) student's drawings to capture their concepts of internal anatomy. As the students were not to be influenced in their drawings, no support could be given to them, which may have made it difficult for them to translate their mental image of the inner organs into a two-dimensional drawing. Especially the finding that students need assistance in mentally transferring from three dimensions to two dimensions (Copolo & Hounshell, 1995) could be another reason for the results described above. It cannot be ruled out that some students of the MG, for example, obtained a differentiated concept of the inner organs because of the three-dimensional model used in the treatment but were unable to translate their mental concept to a two-dimensional drawing (Adamina, 2008; Prokop & Fancovicová, 2006; Reiss & Tunnicliffe, 2001). In this context, the spatial imagination of primary school students should also be taken into consideration, as it is probably not as high as that of adolescents (Yılmaz, 2009). Taking this into account, it would be interesting to modify the capturing of student concepts in future studies. For example, students could be asked to mold organs from plasticine and insert them into a physical model torso, or to draw three-dimensional organs in a virtual torso using augmented reality.

Furthermore, there is a risk of over-interpretation of the drawings, so additional written information can facilitate their interpretation (Piko & Bak, 2006). For this reason, we provided five lines in addition to the outline of the human body in the measuring instrument to give the students the opportunity to write down their ideas about the human organs. Although this option was rarely used, some students wrote down the names of the organs drawn, which was helpful for the interpretation. Nevertheless, some interpretations remained difficult, which is why we involved a second and, where necessary, a third rater to ensure inter-rater reliability. In future studies, the procedure could

be further optimized by asking the students to label the organs they drew using horizontal lines. To optimize insights into treatment-dependent changes in student conceptions in future studies, it would be helpful to analyze the cognitive processes while drawing in real time using the "thinking aloud" method (Olson et al., 1984) or to conduct interviews as suggested by Prokop and Fancovicová (2006).

Other factors affecting the results could be the cognitive developmental level (Copolo & Hounshell, 1995), drawing ability (Prokop & Fancovicová, 2006), and the students' desire to draw. However, as the students in both treatment groups belonged to the same grade and no student submitted a blank sheet of paper, the relevance of these additional factors for the observed inter-treatment differences seem to be negligible. Nevertheless, these potential factors should be controlled in future studies.

Conclusion

With its experimental approach, this study complements previous research on primary school students' ideas about the human body. This is based upon the assumption that the use of physical anatomical models can contribute to a change in students' conceptions about inner organs compared to a CG. As the results show, the intervention not only led to a change in the student's conceptions of the presence, position, systemic integration, and realism of inner organs in the MG treatment but also in the CG. Significant differences in conceptual change between both treatments were only present in relatively few aspects but with more pronounced increases in the CG in terms of the long-term change of systemic integration of the cardiovascular and respiratory systems. There are theoretically derived indications that conceptual change depends on the type of representation offered in both treatments, which presumably supports the analogy conclusion to varying degrees. Future experimental studies will have to show which aspects of these anatomical representations account for the observed differences. This insight into students' conceptions is highly relevant to primary education as it can enable teachers to develop science lessons suitable for conceptual change in relation to human anatomy.

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Students' Mental Addition Strategies and the Effects of Strategy Training: A Longitudinal Study*

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Abstract

This longitudinal study was conducted in order to determine and improve the mental addition strategies of students in their 2nd and 3rd years at elementary school. The first part of the study used the qualitative research method of case study, while the second part adopted the single group pretest-posttest quasi-experimental design. The study group consisted of 16 students who were attending grade 2 at an elementary school in Ankara, and who moved on to grade 3 the following year. In the first part, data were collected from the same students at the end of grades 2 and 3. In the first part of the study, no significant change was observed in the mental addition strategies of students who had passed from grade 2 to 3. In the second part, the same students were trained in "Mental Addition Strategies" for 5 class hours per week for a total of 6 weeks, and the final data were collected. Findings from the first part of the study showed that at both grades they used similar mental addition strategies. The second part of the study, on the other hand, showed that mental addition strategy training increased the variety of the mental addition strategies used by 3rd graders.

Keywords:

Mathematics Education, Elementary Mathematics Course, Mental Calculation, Mental Addition Strategies

Introduction

Aritmetic skills form the basis of mathematics. Mastering operations is an essential skill for children to quickly and competently retrieve and apply this information when necessary. In addition, knowing the basic operational skills paves the way for more advanced mathematical operations. In our daily life, we constantly face situations requiring the four operational skills. Transferring the knowledge gained in mathematics classes into skills and using them to solve daily problems start in earlier years of school life (Baykul, 2009).

In daily life, the four operations (addition, subtraction, division and multiplication) are generally done through four types of calculation methods: calculation via technological tools, written calculation, estimation calculation and mental calculation. In everyday life, estimation and mental

calculation are preferred over others (Van De Walle et al., 2016). In practical solutions to an everyday problem, mental calculation or estimation can be done quickly without the need for paper, pen or a technological tool. There are examples showing that a series of algorithms should be used in teaching basic mathematical operations to elementary students (Baykul, 2009). Children usually learn these basic rules through memorization. However, this method is extremely ineffective as it ignores the principle that numbers are changeable. For example, teaching children to write 24 and place two zeros after it to multiply 24 by 100 is not useful. If students discover this method themselves, they will have sensed a structural feature of the number system (Busbridge & Özçelik, 1997). Also, this method does not offer a framework to help students organize the information that needs to be learned (Tertemiz, 2017). Children will be able to solve everyday problems quickly, accurately and easily by mastering the ability to calculate mentally.

Mental Calculation and Number Sense

The main purpose of mathematics instruction is to equip students with certain essential skills which enable them to learn rather than simply become loaded with information (Olkun & Toluk Uçar, 2018). Number sense plays an important role in the development of mental calculation skills in children. Students arrive at primary school and even kindergarten with various feelings, thoughts and knowledge about numbers. Over time, these feelings, thoughts and knowledge develop and become enriched through formal education or experiences (Barrera-Mora & Reyes-Rodriguez, 2019; Whitacre & Nickerson, 2008). People's knowledge of numbers, operations and their relationships with each other, and their ability to use this information easily in mathematical and everyday problems are directly related to their number sense (Yang et al., 2009; Yılmaz, 2017). According to Hope (1989), number sense is the feeling of being able to make logical predictions with numbers, to perform mathematical operations mentally, to notice number patterns and to choose the most effective solution to a problem involving numbers.

Even though it is difficult to define number sense due to its structure, the components that are effective in the four operations may be listed as follows: knowledge and skills about numbers (noticing the order among numbers), understanding the multiple representations of numbers and feeling their relative size, knowledge and skills about operations (understanding the effects, properties and relationships of operations), using knowledge and skills about numbers and operations in calculations (realizing that the solution may be found in different ways), understanding the meaning and effect of operations (understanding how different operations dictate the results), flexible calculation and counting strategies (mental calculation using knowledge of numbers and operations), being able to judge whether a calculation result is reasonable (judging by calculating by developing mental strategies), numerical estimation (finding the estimated result by rounding the number or using numbers flexibly) (Greeno, 1991; Hope & Sherrill, 1987; Reys et al., 1999; Reys et al., 1982; Şengül and Gülbağcı Dede, 2014; Yang, 2003; Yang and Tsai, 2010). Based on these, it may be stated that the skill of successful mental calculation both indicates and necessitates the presence of number sense so that students can develop their own strategies instead of learning standard rules of mathematics (Henry & Brown, 2008). In sum, children should be encouraged to discover various alternative strategies, such as guessing, mental rounding, knowing the meaning and size of numbers, doing operations, thinking flexibly and using different strategies, instead of depending at all times on rule-based algorithms or a pen and paper. Therefore, developing number sense will help a student to predict the answers to everyday mathematical problems and calculate mentally.

Mental Calculation and Mathematical Reasoning

A number of principles play an important role in the acquisition of the four operational skills. The most important is that these skills are based on advanced counting skills. In addition, structuring numbers (pattern clusters, 1 less/more, 2 less/more considering 5 and 10), which is included in the acquisition of the number concept, is particularly effective in the development of both number sense and mental operation strategies in children. The important thing is to perform multiple operations and see the strategy that suits the child. The teacher should therefore introduce many strategies and focus on the ones that their students find better. An individual's accumulation of knowledge is important in using strategies. The teacher should patiently allow the children to try out different strategies in the four operations and encourage them to discover still different ones, thus enabling meaningful learning. In-class practice should be used as an opportunity to find patterns and relationships (Tertemiz, 2017).

Other principles that are considered fundamental to understanding mathematical operations can be summarized as follows: Harniss et al., (2002. Cited in: Cockburn, 2005) list the principles that form the basis for understanding operations: (1) Place value of a number: The position of a number gives information about the value of the number in question. (2) Expanded notation (representing with signs): Reduction of numbers to digits (for example, the number 437 consists of four 100's, three 10's, and seven 1's), (3) Commutative property: The order of the numbers in an equation does not affect the result (for example, 8 + 7 = 7 + 8).

While this is valid in addition and multiplication, it is not so in subtraction and division. (4) Associative property: The grouping of numbers in an equation may be changed without affecting the result. For example, (8 + 7) + 4 = 8 + (7 + 4). On the other hand, such features are only valid in addition and multiplication. (5) Distribution properties: The distribution of numbers in an equation can be changed. For example, 7 x (8 + 4) = (7 x 8) + (7 X 4), (6) Equality: The number on one side of the "=" sign is equal to the number on the other side. According to Cockborn (2005), these principles affect all basic mathematics topics and are essential to their understanding.

In addition, practicing basic combinations when starting four operations instruction allows students to make sense of these combinations without memorizing them. For example, it is more important to understand that "7+6=13" and see the relationships between the numbers (such as 6+6+1=13 or 7+3+3=13) than to complete the operation accurately. However, when the child goes through this basic process mechanically, conceptual understanding does not occur. For another example, focusing on memorizing rules (such as 7x0=0 or 7x1=7) deprives children of mathematical competence. It also prevents children from contemplating their answers (Baroody, 2006). All these principles play an important role in mentally estimating results and checking the results in written operations and the problem solving process.

Mental calculation of the four operations needs to be considered together with mathematical thinking and reasoning skills. Reasoning is an important building block in learning mathematics, making sense of concepts and relationships, applying mathematics and defending ideas (Köse, 2016; Viseu, et al., 2021). Reasoning is the process of arriving at a rational conclusion by thinking through all aspects of a situation. Those who can reason on a subject have sufficient knowledge on that subject. They can compare their existing knowledge with new situations, examine all their dimensions, discover, make logical predictions, explain the reasons for their thoughts, reach conclusions, and explain and defend them (Ulu & Özedemir, 2018; Umay, 2003). To examine the student's reasoning process, it is necessary to ask questions such as "How did you reach this conclusion?" or "What did you focus on to reach this conclusion?" rather than to look at the accuracy or inaccuracy of the answer to a question. Or it is necessary to ask questions regarding the process incomplete or incorrect word choice. With these kinds of questions, adults gain insight into children's reasoning processes (Piaget, 2011). Mathematical skills support one another and are learned and developed as they are used. It is therefore not possible to evaluate reasoning independently from prediction, or mental calculation skills independently from number sense. Each is a skill used to improve and strengthen the other (Olkun, 2005; Ozsoy, 2012).

It is very difficult to acquire mental calculation skills in a few class sessions. Several techniques may be suggested to acquire this skill, but there is no standard teaching method or algorithm (Baykul, 2009; Van De Walle et al., 2016). Students may develop their own strategies after studying various examples. In order to develop these strategies, the first step is to know what they are. There are operations-specific strategies for mental addition, subtraction, multiplication and division. The present study is limited to mental addition operations. This is because mental addition is considered to be the foundation for the learning of other mental calculation skills (subtraction, multiplication and division) and to affect future processes.

Mental Addition Strategies

Among the four operations, the first one to be tackled is "addition" as it serves to teach and supports the other three operations (Liu et al., 2019). For example, multiplication is taught through repeated addition, and subtraction is taught through finding the unknown addend. Acting as a foundation for other operations, addition is affected by students' problem solving experiences, working memory capacities, age or schema automation (Imbo et al., 2007; Arnaud et al, 2008). This suggests that the mental addition strategies of individuals who are negatively affected by these variables remain weaker, or that individuals who are positively affected can develop a number of different strategies.

Baykul (2009) categorizes mental addition strategies under three main headings: "adding by taking advantage of the change and merge feature of addition", "adding by breaking the numbers down", and "adding the same number to one addend and subtracting it from the other". In general, since it is easier to add small numbers to large numbers than vice versa, whenever there is a larger number after a small number in an addition problem, the operation may be made easier by changing the places of numbers by using the change feature. Such addition problems may be facilitated by using the strategy of "adding by using the change and merge feature". In some cases, especially when adding one and two-digit natural numbers, breaking down the numbers in appropriate ways facilitates addition. This is known as the "adding by breaking the numbers down" strategy. Based on the characteristics of numbers, the breaking down may be done by using one of the following strategies: Completing to 10 or 100, making use of subtraction, breaking numbers down by multiples of 10, adding the digit values of numbers, adding by counting, and adding by rounding one of the numbers to 10. When the same number is added to one of the

addends and subtracted from the other, the result of the addition does not change. This feature of the addition operation is known as the strategy of "adding the same number to one addend and subtracting it from the other". This strategy requires determining a suitable number to add to and subtract from the given numbers.

Strategies for mental addition have been categorized differently by different researchers. In the present study, the classification of Reys et al. (1995; p.310) was used for its comprehensiveness. The categorization is shown in Table 1 below.

As can be understood from Table 1, there are various strategies to be used in developing students' mental addition skills in mathematics classes. Also, mental addition has a two-way relationship with number sense, mathematical reasoning, and prediction skills.

Related Studies

When studies on mental calculation are examined, it can be seen that the topic has mostly been addressed in studies on number sense. Previous studies have concluded that there is a relationship between mental calculation skill and number sense in children (Heirdsfield, 2001; Heirdsfield, 2002), and that education can improve children's estimation and mental addition skills. Yazgan et al., (2002) and Siegler and Booth (2005) have stated that learning environments that encourage free exploration enable students to discover the relationships between numbers and operations, while McGuire et al., (2012) and Yang and Li (2013) noted that flexible mental calculation, estimation and decision-making skills about numerical values are dimensions that strengthen number sense. Regarding the topic of the present study, Aydın Güç and Hacısalihoğlu Karadeniz (2016) found that the most common strategy used by 5th graders during mental addition is the strategy of adding by using the change and merge feature of addition, and the least commonly used one is to break the numbers based on multiples of 10. Similarly, Duran et al., (2016) reported that the most common strategy among middle school students was "adding by dividing into tens and ones" while the least used one was "breaking down the numbers by taking 10 as reference".

On the other hand, certain studies examining children's knowledge and skills on numbers and operations revealed situations where children faced difficulty. These included children tending to use procedural algorithm in operations due to poor number sense perception, having a lack of understanding in numbers and operations, being better at memorized rules, regressing in intuitive number comprehension due to excessive dependence on pen and paper calculations, making mistakes related to "0" in operations (such as 4x0x3=12), having problems with digit value, and mostly doing operations from left to right (Mastrothanasis, Geladari et al., 2018; Rogers, 2014; Singh et al., 2019; Yang & Sianturi, 2019). As shown by previous studies, the development of mental calculation skills cannot be considered separately from children's number sense, their skills and the instruction offered. The knowledge and skills involved in this process directly affect each other as well. For example, while advanced number sense affects how operations are done, operation skills affect understanding the relationships among numbers. Therefore, this study aims to determine students' mental addition strategies on the one hand, and to contribute to the development of their strategies, save them from finger calculations, and help them make an easy transition to mental calculation on the other hand. Another rationale for the study is the belief that "Starting from grade 2, strategies for calculating with whole numbers should be the focus so that children's attention, flexibility and calculation fluency can develop by understanding natural numbers, addition and subtraction" (NCTM, 2000: 35, cited in Buchholz,

Table 1.
The Strategies Expected in Mental Addition (The example of 79+26)

A. Breaking into tens and ones	
A1. From left to right (Tens first)	(70+20=90; 9+6=15; 90+15=105)
A2. From right to left (Ones first)	(9+6=15; 70+20=90; 15+90=105)
A3. Cumulative addition	(70+20=90; 90+9=99; 99+6=105)
B. Keeping one addend constant	
B1. First addend	(79+20=99; 99+6=105)
B2. Second addend	(26+70=96; 96+9=105)
C. Rounding one or both addends to multiples of 10 and adjusting	
C1. First addend	(80+26=106; 106-1=105)
C2. Second addend	(79+30=109; 109-4=105)
C3. Both addends	(80+30=110; 110-1-4=105)
D. Rounding both addends to multiples of 5	(75+25=100; 100+4+1=105)
E. Using paper-pencil strategy mentally	
F. Saroban's mental image	

2004). In this way, students will produce a number of interesting and useful strategies to solve problems (Buchholz, 2004). Determining the strategies used by second graders when adding mentally is also believed to be important as applying the same procedure on the same students the following year in grade 3 can show their longitudinal development.

Purpose

The first part of this study aimed to determine the mental addition strategies of students at the end of grades 2 and 3, while the second part aimed to determine the effects of mental addition strategy training on the diversity of students' strategies.

In line with this general purpose, the following sub problems were studied:

- What strategies do students use when adding mentally at the end of grade 2?
- What strategies do the same students use when adding mentally at the end of grade 3?
- Which strategies do 3rd graders use when adding mentally after mental addition strategy training?
- Do mental addition strategies of 2nd and 3rd graders change from one year to the next, and before and after training?

Method

Study Design

The mixed-methods sequential explanatory design was used in this longitudinal study. In this design, the qualitative aspect of the study is applied first, and the quantitative research process is undertaken according to the results obtained. As it is sequential, the design does not allow the favoring of the quantitative or qualitative method over the other (Bowen et al., 2017; Ivankova et al., 2006). Cresswell and Plano Clark (2011) state that the results obtained from the qualitative data in this design determine the design of the subsequent quantitative dimension. The reason for conducting the study longitudinally is that it provides the opportunity to collect in-depth information about the same person or group by examining the change in the study group or variables over time, starting from a prespecified starting point until the study is complete, continuously or at certain intervals. Although the units followed in longitudinal studies are generally small in number, they yield deeper and more comprehensive information compared to other studies (Karasar, 2014).

The qualitative method was used when determining the mental addition strategies of the same 2nd and 3rd graders in the first part of the study as this method allows to explain the meanings and relationships from part to whole by questioning human problems via techniques such as observation and interview (Neuman, 2014, p. 634). The qualitative research method of case study was preferred as it provides the opportunity to examine a situation or a specific event at depth (Merriam, 1998).

In the second part of the research, after it was concluded that "no significant change occurred in the mental addition strategies of children who moved from grade 2 to 3", a training program was implemented to develop the mental addition strategies of 3rd graders, and the single group pretest-posttest experimental design was used to determine its effectiveness. In this design, the effect of the experimental process is tested via studies performed on a single group. The measurements of the subjects related to the dependent variable are obtained via a pretest prior to the study and a posttest afterwards, by using the same subjects and the same measurement tools (Büyüköztürk et al., 2015). The symbolic representation of the pattern is given in Figure 1.

Figure 1.
Single Group Pretest-Posttest Design

Group	Pretest	Process	Posttest
G	O_1	X	O_2

Study Group

The study group comprised a total of 16 second graders from an elementary school located in the Keçiören district of Ankara, who then moved on to the 3rd grade and remained in the same section. The study group was determined by using the non-random sampling method known as "Convenience Sampling". As the researcher in this method chooses a situation that is close and convenient to access, it adds speed and practicality to the study (Yıldırım ve Şimşek, 2016). Of the participants, 8 were male (S-1, S-2, S-3, S-4, S-5, S-6, S-7, S-8) and 8 were female (S-9, S-10, S-11, S-12, S-13, S-14, S-15, S-16).

Data Collection Tool

In order to determine students' mental addition strategies, 8 questions which would allow the use of different strategies were prepared. The questions were at an appropriate level for grades 2 and 3, and in line with the objectives stated in the Elementary Mathematics Curriculum (MEB, 2018). The objectives, their scope and sample questions are given below. The mental addition strategies offered by Reys et al., (1995) were taken into consideration as the questions were prepared, and care was taken to stay within the scope of the objectives. At every stage of the research, students were asked eight additions. In the preparation of the questions, the learning outcomes given in Table 2 were taken into consideration. In the

study limited to learning outcomes, eight questions in three different forms each, which were similar to sample questions, were prepared. While preparing the questions, 4 questions for each learning outcome and eight questions in total for 2nd grade were asked. As for 3rd grade, at least two questions and eight parallel questions for each in total were prepared for each learning outcome.

Data Collection

Data in the first part of the study was collected at the end of grade 2 and the end of grade 3 from the same students, while data in the second part was obtained in the same way at the end of grade 3 after the experimental process.

In the evaluation of cognitive and upper cognitive strategies, mostly verbal reporting techniques are used. Since the application of think aloud protocols are realized within a learning activity (as an example, text reading or solving a mathematics problem), the fact that participants are informed in detail about mental strategies and that information is not lost is pointed out as the most significant advantage. Think aloud learning process is realized with student in three stages. In the first stage, the operator first explains the purpose of the study, informing about why think aloud techniques is a good way to understand how students solve a mathematical problem (Özkubat & Özmen, 2018). In the current study, the operator explained the purpose of study to the students and told them how to do think aloud protocol as follows: "I am interested in how you do additions mentally (without using pen and paper); therefore, I will ask you processes respectively so that you can do additions and listen to you how you do these processes. How you do is of importance for me, so I will use this recording device in order to be sure that you do not forget anything you say". In addition, the students were asked the question of "How did you find it?" after each answer in order to determine the first strategy coming to their mind while doing the processes in a clear and correct way. Following the introduction given, the operator becomes a model in the think aloud process about a mathematical operation in the second stage. In this process, operator thinks aloud over a mathematical operation by exhibiting such behaviours as self -questioning, self-instruction and self-monitoring (Özkubat & Özmen, 2018). In this study, the operator similarly became a model to the students once for each. At the last stage, the operator completed the training part of think aloud protocol by supporting the suitability and understandability of the tone of voice of the student during the process of mental aloud operation.

Experimental Process

During the experimental process, several "Mental Addition Strategies" were taught to 3rd graders 5 hours weekly for 5 weeks. These strategies were selected by taking into account the "Strategies Expected to be Used in Mental Addition" by Reys et al., (1995) and the 3rd grade addition objectives listed in the Elementary Mathematics Curriculum. The strategies included in the program were as follows:

Table 2.
Objectives of the Elementary Mathematics Curriculum and Sample Questions

Objectives and Scope	Sample Question
M.2.1.2.4. Can do mental addition.	
Mental additions are done with the number 10 and natural numbers that are multiples of 10 whose maximum sum is 100.	40+50=?
After this, two natural numbers whose sum does not exceed 50 are added mentally.	24+24=?
M.3.1.2.4. Can do mental addition.	
Mental additions are done with two two-digit numbers whose sum does not exceed 100;	76+21=?
A three-digit number and a single digit number;	283+7=?
A two-digit multiple of 10 and a three-digit multiple of 100.	800+70=?

Table 3.
Mental Addition Strategies Used in the Study and Sample Questions

Mental addition strategies	Sample Questions
Using paper-pencil strategy mentally	24+24=? 4+4=8; 2+2 =4; 48
The strategy of rounding both addends to multiples of 5	34+47=? 35+45= 80; 80-1+2= 81
The strategy of rounding one addend or both to tens	39+43=? 40+40= 80; 80-1+3= 82
The strategy of breaking into tens and units	62+24=? 60+20=80; 2+4= 6; 80+6= 86
The strategy of keeping one addend constant	76+21=? 76+20=86; 86+1= 87

For the instruction of each strategy within the scope of the study, prerequisite learning (skip counting and addition skills, etc.) was first ensured, lacks were amended and mistakes were corrected (Koç, 2018). After the preliminary work, each strategy was taught with the following learning-teaching cycle designed by the researcher teacher and a field expert academic.

Present the problem: The students were presented with a problem in line with the targeted strategy. Get the student to discover: This stage involved the discovery of the targeted strategy by the students. To ensure this, clues and guidance were offered. Recognizing the clues that students need in this stage and guiding them with the right questions require experiences teachers who know their students well. The clues sometimes involved asking questions with smaller numbers, which might be the simplest representation of the strategy, and at other times they involved the transfer of a previously learned topic to the learning environment.

Name the discovered strategy: Students named the strategy as a whole class. They were asked to engage in instructional strategies such as brainstorming, discussions, group work, etc. to express their views. What is important here is to guide the students in choosing a name that matches the nature of the strategy. For instance, the strategy of separating into tens and units may be given similar names such as the strategy of separating into digits, units first-tens later strategy, or tens first-units later strategy and so on.

Reinforce: This aimed to enable the students to fluently use the learned strategy in different questions and problems. By this stage, the strategy is already discoveredi and named commonly by the whole class. The aim of this stage may also be achieved in different ways according to the physical characteristics of the classroom or different student traits. To illustrate, according to the strategy where discovery happens through asking a question to the class, students were asked to solve the problem in small groups and then explain it to other students. This continued until each student was able to ask a question. The students were asked to use this strategy, add mentally, and check from a calculator. In order to explain the use of this strategy to their classmates, the students designed games and competitions and made videos, or had to teach the newly learned strategy to two people from their families. The cycle was repeated until all strategies were reinforced. After the experimental process (in the second phase of the study) think aloud protocols were held once again with 16 students, and these interviews were audio-recorded to avoid loss of data. The recordings were played to identify the strategies that students chose to use.

Data Analysis

In data analysis, interview recordings were played and the strategies preferred by students were coded in line with the table of expected strategies for mental addition developed by Reys et al. (1995). The findings were supported with direct quotations.

The following measures were taken to ensure validity and reliability, as suggested by Erlandson et al., (1993, cited in Yıldırım and Şimşek, 2016, p. 277-283).

Table 4.

Measures for Validity and Reliability

Internal Validity (Credibility)	Long term interaction In-depth data collection Expert examination Participant confirmation	While presenting the data, sample quotations for the answers of the students were given place. During these quotations, it was paid attention that the samples were comprised of the views reflecting the general answers.
External Validity (Transferability):	Using direct quotations Detailed description of the data collection tools, environment and stages of the study	In order to increase the possibility of being transferability, detailed descriptions were given place. In other words, data collection process, selection of participants and how the obtained data was analysed was explained in detail.
Internal Reliability (Consistency):	Checking validity (Examination of all stages of the study by an outsider) Two researchers acting together in all stages of the study	To obtain the consistency, the answers given by the students were firstly coded independently by two researchers and then, different codes were determined by coming together, and the discussion was carried on until getting a consensus. The codes obtained were presented by enumerating with repetition frequency.
External Reliability (Confirmability):	Offering explanations about data collection and analysis methods Checking confirmation (comparison of raw data with researcher's interpretations)	The data set was recorded in different times and controlled, so the confirmability of the research was tried to be obtained.

Findings and Interpretations

In this section, the methods that students use while adding mentally are presented under subtitles that consist of the research questions.

The First Stage of the Study: The Strategies Used by Students When Adding Mentally At the End of Grade 2

In order to determine second graders' mental addition strategies, an answer to the following question was sought: "What strategies do 2nd graders use when adding mentally?" Eight questions were asked to 16 students each. All students were observed to answer correctly after being given enough time. The findings are presented in Table 5.

The voice recordings of the students regarding their mental additions were analyzed with respect to the five strategies. Based on how frequently they were preferred in the present study, these strategies can be listed as follows from the most commonly preferred to the least:

"Using paper-pencil strategy mentally" was preferred 82 times and became the most preferred strategy. The second most preferred strategy, "rounding one or both addends to a multiple of 10" was used 19 times. This was followed by the strategies of "keeping an addend constant and breaking it into tens and ones", both of which were preferred 13 times. Among those who preferred to keep an additive constant, almost all preferred to keep the first addend. In the strategy of breaking up into tens and ones, almost all students started from the right that is by adding the ones first.

The least preferred strategy was "Rounding both addends to a multiple of 5", preferred by only one. Also, a general look at the table shows that while half of the students preferred to use 3-4 different types of strategies, the other half preferred to use only one.

The Strategies Used by Students When Adding Mentally at the End of Grade 3

In order to determine the same students' mental addition strategies a year later in grade 3, an answer to the following question was sought: "What strategies do 3rd graders use when adding mentally?" Eight questions were asked to 16 students each. All students were observed to answer correctly when given enough time. The findings are presented in Table 6.

Table 5.
Mental Addition Strategy Preferences of 2nd Graders

Grade: 2	Breaking into Tens and Ones			Keeping One Addend Constant		Rounding One or Both Addends to Multiples of 10			Rounding Both Addends to Multiples of 5	Using Paper-Pencil Strategy Mentally	Total Number of Questions Answered
Participant	From left to right (tens first) f	From right to left (ones first) f	Cumulative addition f	First addend f	Second addend f	First addend f	Second addend f	Both addends f	f	f	f
S1				5		1	2				8
S2				2	1	1	1	2	1		8
S3	1	2						1		4	8
S4						1	1	2		4	8
S5										8	8
S6				3						5	8
S7		4								4	8
S8		4								4	8
S9										8	8
S10										8	8
S11				2		1				5	8
S12	1	1				1	1	4			8
S13										8	8
S14										8	8
S15										8	8
S16										8	8
Total	2	11	0	12	1	5	5	9	1	82	128
Overall Sum			13		13			19	1	82	128

Table 6.

Mental Addition Strategy Preferences of 3rd Graders Prior to Training

Grade: 3	Breaking into Tens and Ones			Keeping One Addend Constant		Rounding One or Both Addends to Multiples of 10			Rounding Both Addends to Multiples of 5	Using Paper-Pencil Strategy Mentally	Total Number of Questions Answered
Participant	From left to right (tens first) f	From right to left (ones-first) f	Cumulative addition f	First addend f	Second addend f	First addend f	Second addend f	Both addends f	f	f	f
S1	1	1		1		1	1			3	8
S2	1	1								6	8
S3		1		2						5	8
S4	1	1							1	5	8
S5	1			3						4	8
S6	1			1		1	1			4	8
S7	2	1								5	8
S8	1	1		3				1		2	8
S9	2	1		1						4	8
S10	2	1		1	1		1			2	8
S11						1		4		3	8
S12			1				1			6	8
S13		2				1		2		3	8
S14		2						1		5	8
S15						1		1		6	8
S16					2			1		5	8
Total	12	12	1	12	3	5	4	10	1	68	128
Overall Sum			25		15			19	1	68	128

As can be understood from Table 6, it was found that the most commonly used mental addition strategy among 3rd graders was "using paper-pencil strategy mentally". This strategy was preferred 68 times. In other words, the students verbally stated the sequence of procedures that they applied on paper with the help of a pen. The second most preferred strategy, "breaking it into tens and ones", was preferred 25 times. The third most commonly preferred strategy was "Rounding one or both addends to a multiple of 10", used 19 times. The fourth most frequently used strategy was that of "keeping an addend constant", used 15 times. Among the sub-strategies of this basic strategy, "keeping the first addend constant" was preferred 4 times more than "keeping the second addend constant". The least preferred strategy was "rounding both addends to multiples of 5". It was chosen by one student only once.

When Tables 5 and 6 are examined together, it can be seen that the most preferred mental addition strategy in both grade levels when the students passed from grade 2 to 3 was "using paper-pencil strategy mentally". The strategies of "rounding both addends to a multiple of 5" and "rounding one or both addends to a multiple of 10" were used the same number of times in the two grade levels. This was also the case with the strategy of "keeping an addend constant". On the other hand, the strategy of "breaking into tens and ones" was preferred more in the 3rd grade.

The Second Stage of the Study: The Strategies Used by 3rd Graders When Adding Mentally After Mental Addition Strategy Training

The third sub-aim of the study was "Which strategies do 3rd graders use when adding mentally after mental addition strategy training?" Eight questions were asked to 16 students each. All students were able to answer correctly after being given enough time. Table 7 presents the findings.

Table 7.

Mental Addition Strategy Preferences of 3rd Graders after Training

Grade: 3	Breaking into Tens and Ones			Keeping One Addend Constant		Rounding One or Both Addends to Multiples of 10			Rounding Both Addends to Multiples of 5	Using Paper-Pencil Strategy Mentally	Total Number of Questions Answered
	From left to right (tens first)	From right to left (ones first)	Cumulative addition	First addend	Second addend	First addend	Second addend	Both addends			
Participant	f	f	f	f	f	f	f	f	f	f	f
S1	1			1	1		1	1	2	1	8
S2	1		1		1	1	1		1	2	8
S3	1	1		1		1	1		2	1	8
S4		2		1		1		2		2	8
S5				1	1	1		2	1	2	8
S6		1	1	1		1		2		2	8
S7	1					2	1	2	1	1	8
S8	1			1	1		1	2	1	1	8
S9	1		1		1	1	1		1	2	8
S10	1					2	1	1	2	1	8
S11	1		1	1	1	2	1			1	8
S12	1			1	1	1	1	1	1	1	8
S13	1			1	1	2		2		1	8
S14	2	1		2		1		1		1	8
S15	1	1		1		1		1	1	2	8
S16	2			1	1	2		1		1	8
Total	15	6	4	13	9	19	9	18	13	22	128
Overall Sum			25		22			46	13	22	128

From a general perspective, Table 7 shows that the diversity of strategies that students were using increased after mental addition strategy training. In other words, it can be said that students could use various strategies. It was seen that the most commonly preferred mental addition strategy (46) was "rounding one or both addends to multiples of 10". The second most popular strategy (25) was "breaking into tens and ones". The two strategies that were preferred in medium frequency were "keeping an addend constant" and "using paper-pencil strategy mentally". A decrease may be seen in the use of the latter strategy. The strategy of rounding both addends to a multiple of 5 was used 13 times. Although this strategy seems to be used relatively less than others, it must be noted that this strategy, which was preferred only once by one student in the two think aloud protocols before the experiment, was preferred 13 times after it.

Comparison of Students' Mental Addition Strategies from Grade 2 to 3 With Respect to Grade and Training

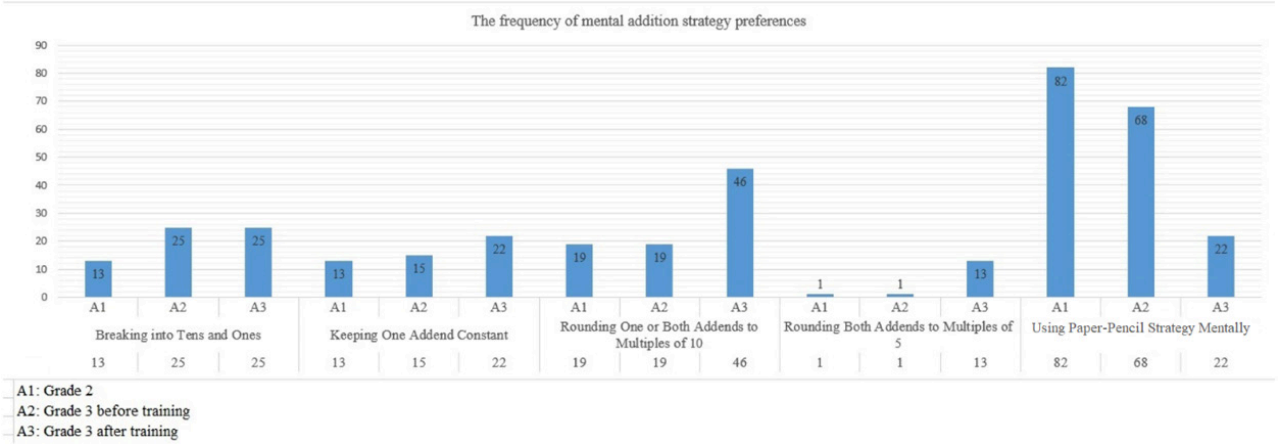
The 4th sub-problem of the study was "Do mental addition strategies of the same 2nd and 3rd graders change from one year to the next, and before and after training?" Chart 1 presents the frequency of mental addition strategy preferences by the same students in grades 2 and 3, based on grade level, and before and after training.

The chart above shows the frequency of mental addition strategies preferred by the same students in grades 2 and 3 before and after strategy training.

The most striking change that can be observed in the chart is the fall in the strategy of "using paper-pencil strategy mentally" from 82 to 68 and to 22. While the strategy of "rounding the addends to multiples of 5" was preferred only once by one student before the experiment, it was preferred 13 times afterwards. While the strategy of "rounding the addends to multiples of 10" was preferred 19 times before the experiment, it increased significantly to 46 after the application. The strategy of "breaking into tens and ones" was chosen the same number of times, 25 before and 25 after the mental addition training. While the strategy of

Chart 1.

The mental addition strategies of the same students in grades 2 and 3, and their strategies with respect to grade level and training



"keeping an addend constant" was preferred 15 times before the experiment, it was preferred 22 times after it. The overall facts shown in the chart; namely, the significant decrease in the pen and paper strategy, the 13-fold increase in rounding to multiples of 5, and the significant increase in rounding to multiples of 10, may point to the effectiveness of the mental addition strategy training.

Sample Student Answers

This section gives examples of how 2nd graders and 3rd graders before and after the experimental procedure solved the mental addition questions asked to them.

Sample 2nd grader strategies

A student who mentally computed 24+30 (S2), stated that the sum was 54. After this answer, the following dialogue took place between the researcher and the student:

Researcher: How did you reach this sum?

S2: I saved 30. I added 20 to it to reach 50. Then I added 4 and reached 54.

Researcher: Why didn't you save 24 but 30?

S2: As 24 is a smaller number, it's easier to add it to 30.

(The strategy used: Keeping one addend constant)

As can be seen, the student chose to keep one of the addends constant and added the other one. He explained his reason for keeping the second addend constant instead of the first one as the former being larger, and the smaller number being easier to add.

Another student who mentally computed 32+12 (S7) found the sum as 44. Following this answer, the dialogue below took place between the researcher and the student:

Researcher: How did you find this result?

S7: I added 30 and 10 and reached 40. Then I added 2 and 2 and reached 4. Finally, I added 4 to 40 and reached 44. (The strategy used: Breaking into tens and ones)

Sample 3rd grader strategies before mental addition strategy training

The following dialogue took place between the researcher and a student who mentally added 67+16 (S12) and answered 83:

Researcher: How did you reach the answer 83? Will you tell me step by step?

S12: I first rounded 67 to 70. Then I added 70 and 16.

Researcher: OK fine, how did you add 70+16?

S12: As 70 is larger, I kept it and added 10 to it to reach 80. Then I added 6 and the result was 86.

Researcher: You said it was 83. Then what did you do?

S12: At the beginning, I had increased the number by 3 when I rounded 67 to 70. Therefore, I need to subtract 3 from the sum. Three minus 86 is 83.

(The strategy used: Rounding one or both addends to a multiple of 10)

Sample 3rd grader strategies after mental addition strategy training

A student who mentally computed 283+8 (S5) answered 291, and the following dialogue occurred between this student and the researcher:

Researcher: How did you reach 291? Will you explain step by step?

S5: I accepted 283 as 285. So I increased the number by 2. I must remember this. I rounded 8 back to 5. Here, I decreased the number by 3. I'll remember this, too.

Researcher: Why did you do these?

S5: Because it's easier when the numbers are rounded to multiples of 5.

Researcher: OK, what did you do afterwards?

S5: Now I have 285 and 5. If I add them up, the result is 290.

Researcher: Fine. Is the operation finished now?

S5: No. As I had increased the number by 2 at the beginning, I need to first subtract 2. But I also took off 3 from the other addend, so I'll add 3.

Researcher: Well done! Go ahead.

S5: First I will add 3. If I add 3 to 290, I get 293. When I subtract 2 from 293, then the answer is 291. (The strategy used: Rounding both addends to a multiple of 5)

Results Discussion and Recommendations

The aim of this study was to determine the mental addition strategies used by the same students while attending grades 2 and 3, and to develop strategies they can access with mental addition strategy training implemented at the end of grade 3. In this section, the results derived from the findings of the sub-problems are discussed and several recommendations are made.

In the first and second sub-problems of the study, the mental addition strategies used by 2nd and 3rd graders were determined. The results showed that almost half of the students in grade 2, which was discussed in the first part of the study, and half of those in grade 3 could only use the strategy of "using paper-pencil strategy mentally" before the training. In other words, they could verbally express the algorithmic sequence of operations they applied with pen and paper. This result reveals that, when adding mentally, students often employed the algorithmic strategies they learned at school rather than alternative strategies. Corroborating these findings, Mastrothanasis et al., (2018) studied 80 students at grades 3, 4, 5 and 6 to determine their mental addition and subtraction strategies, and found that most could only mentally perform algorithmic operations with the help of pen and paper, and could not use more complicated strategies effectively. Yang and Sianturi's (2019) finding that children tend to do mostly operations from left to right was similar to the result of a study on secondary school students conducted by Singh et al., (2019). Huang and Yang (2018) studied the strategies used by 4th graders when solving questions necessitating number sense, and found that children used rule-based strategies, but middle and low-level children were more inclined to use these strategies. However, in a noteworthy study by Duran et al., (2016) focusing on the mental calculation strategies of middle school fifth graders when adding and subtracting, it was found that students did not use any strategy correctly and could not answer the questions.

Another result of the present study is that, when the same students at grades 2 and 3 performed mental addition prior to the training, they used the strategy of "rounding both addends to multiples of 10" only at a limited level, and they did not know or use the strategy of "rounding to multiples of 5". This may be attributed to the fact that the course curriculum outcomes do not adequately emphasize rounding to multiples of 5 (MEB, 2018). Likewise, Aydın Güç and Hacısalihoğlu Karadeniz (2016) found via think aloud protocols with 25 fifth-graders that most of them did not use mental addition strategies, preferred conventional strategies when computing mentally, and tried to solve most questions they encountered by using the same strategies.

In the present study, third graders were observed to have improved their addition strategies by breaking into tens and ones. This result may be a sign that the concept of place value is better understood by 3rd graders and that children can transfer this knowledge to the process of mental addition. Kamii (1986) views the concept of tens as a hierarchical system built on the already existing concept of ones. However, it is stated that early teaching of the concept of digits may cause tens and ones to be constructed separately in children's minds. Even though it may be considered appropriate to teach the concept of digit in early grades (Fuson & Briars, 1990), it is important to consider children's readiness levels. Contrary to the findings obtained, Yang and Sianturi (2019) reported difficulties by children with place value in their study about number sense. Children have difficulty understanding that a number increases ten times when it is multiplied by 10, or decreases ten times when divided by 10 (Rogers, 2014). Another result obtained in the study is that the diversity of the mental addition strategies used by 2nd and 3rd graders did not vary significantly. Similarly, Rezat (2011) studied 8th graders and concluded that they could use a single type of strategy when mentally adding rational numbers. This result parallels previous findings regarding mental calculation strategy use with natural numbers.

When the mental addition strategies of 3rd graders before and after instruction were compared, a

significant increase was observed in the number and variety of strategies used after the instruction. Similarly, Yazgan et al., (2002), in their 8-week study aiming at developing elementary 5th grade students' mental calculation and estimating skills, concluded that these skills in children could be improved through education. By the same token, Heirdsfield and Lamb (2005) concluded that instruction on mental addition and subtraction led to a decrease in the use of useless strategies and an increase in more complicated ones among some 2nd graders, and to an increase in the variety of strategies used by those who could already use complicated strategies at the beginning. In other words, the results obtained from previous studies suggest that the teaching of mental addition strategies can contribute to students. Also, considering "calculation by using flexible calculation and counting strategies", which is an important component of number sense, children are expected to be able to use the various operation strategies mentioned in the study. This also hints at the development of number sense in children (Reys et al., 1999; Yang, 2003).

When the results of the present study and those of the previous ones are considered together, it is obvious that opting to use standard methods alone in mental calculation skills training may cause students to use conventional algorithmic rules when performing mental operations. This raises questions about whether or not classwork focuses on developing mathematical reasoning and thinking skills or student generated strategies. Also worth noting is the belief that an operative level of mathematical knowledge on the teacher's side may influence teaching style. When listing the action principles of mathematics education, the NCTM (2020) emphasizes the complexity of the process and the importance of teacher quality for deep learning. For these reasons, a deeper examination of the process may be recommended.

It would be useful to mention about the two limitations of the current study. The first one is that the questions asked to the students were prepared within the content of the learning outcomes regarding mental additions taking place in the Elementary Mathematics Curriculum for the 2nd and 3rd graders. The other limitation is that it is only limited to "Strategies Expected to be Used in Mental Addition" by Reys et al., (1995). For that reason, it is likely to see which group the children will choose and why they choose this group by given flexible number groups (e.g., 37+4, 50+30, 45+27). In other words, whether the given numbers have an effect on the strategy selection can be investigated in detail. Whether mental strategy preferences of the students will change depending on numbers or different strategy teaching is a case to be considered. In addition, only addition was studied in the current research. Similarly, some other studies could be carried out into other mental processes (subtraction, multiplication, division) and and at different grade levels.

In conclusion, the classroom environment should be one where children can share their thoughts and discuss their own mathematical ideas so that their mental calculation strategies may be enriched (Van De Walle et al., 2016). Having a classroom environment where children are not afraid to make mistakes, develop new ideas, receive encouragement for different mental calculation ideas, and share and discuss their opinions would increase participation in class. It would therefore be beneficial for teachers to use the mental addition strategies mentioned in this study or others with similar characteristics in their classrooms. Finally, future researchers may be recommended to hold in-depth examinations of classroom practices and textbooks by considering to what extent they include mental calculation strategies.

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