ISSN: 1300-915X

IOJPE

INTERNATIONAL ONLINE JOURNAL OF PRIMARY EDUCATION

International Online Journal Of Primary Education

Volume 12 - Issue 1

International Online Journal of Primary Education

ISSN: 1300-915X

MARCH 2023

Volume 12 – Issue 1

Prof. Dr. Nergüz BULUT SERİN
Editors in Chief

Prof.Dr. Mehmet Engin DENİZ
Prof. Dr. Şule AYCAN
Prof.Dr. Oğuz SERİN
PhD. Arzu GÜNGÖR LEUSHUIS
Editors

Published in TURKEY
Contact Address:
Prof. Dr. Nergüz BULUT SERİN
IOJPE Editor in Chief, İzmir-Turkey

Message from the Editor,

I am very pleased to inform you that we have published the first issue in 2023. As an editor of International Online Journal of Primary Education (IOJPE), this issue is the success of our authors, very valuable reviewers who undertook the rigorous peer review of the manuscripts, and those of the editorial board who devoted their valuable time through the review process. In this respect, I would like to thank to all reviewers, researchers and the editorial board members. The articles should be original, unpublished, and not in consideration for publication elsewhere at the time of submission to International Online Journal of Primary Education (IOJPE). For any suggestions and comments on IOJPE, please do not hesitate to send me e-mail. The countries of the authors contributed to this issue (in alphabetical order): Australia, Nigeria, Turkey, and United States.

Prof. Dr. Nergüz BULUT SERİN

Editor in Chief

ISSN: 1300-915X

Volume 12, Issue 1 (2023)

Table of Contents

Research Articles

ISSN: 1300-915X

IOJPE

ISSN: 1300 – 915X
www.iojpe.org

International Online Journal of Primary Education *2023, volume 12, issue 1*

REACHING CHILDREN ACROSS THE GLOBE: THE EFFECT OF ENGLISH CHILDREN'S BOOKS ON TANZANIAN ORPHAN LITERACY

Janet PROVITERA
Barry University, Florida, United States
ORCID: https://orcid.org/0009-0002-0872-0283
janet.provitera@mymail.barry.edu

Michael J. PROVITERA
Associate Professor, Barry University, Florida, United States
ORCID: https://orcid.org/0000-0002-2124-7171
Barry University, Florida, USA
MProvitera@barry.edu

Mostafa SAYYADI
Australian Institute of Management, Sydney, Australia
ORCID: https://orcid.org/0000-0002-9229-2404
mostafasayyadi1@gmail.com

Received: December 04, 2022 **Accepted:** February 24, 2023 **Published:** March 31, 2023

Suggested Citation:
Provitera, J., Provitera, M. J., & Sayyadi, M. (2023). Reaching children across the globe: The effect of English children's books on Tanzanian orphan literacy. *International Online Journal of Primary Education (IOJPE), 12*(1), 1-14. https://doi.org/10.55020/iojpe.1274257

Abstract

We found that there are disproportionately intractable challenges such as poverty and inequality in an area of Tanzania, Eastern Africa. There was a need to identify and develop the factors critical for their success. Data were collected in rural Iringa, Tanzania on a case study basis, using a semi-structured interview and communication with leaders in this area of Africa, and we analyzed data with a coded transcript. We identified ten factors that are critical for the success of the orphanage literacy. These findings advance understanding of non-governmental organizations (NGOs) and have important practical applications for such enterprises. When the United Nations literacy decade (UNLD, 2003–2012) reached a mid-point, we decided to add to the global awareness of literacy. With initiatives and policy shifts providing a stronger basis for action on literacy, we reached out to Africa. Our concern is that the rise in the global adult literacy rate (15+) from 76 to 83.6 percent over the last two previous decades shows steady progress, with the rates in developing countries showing an even sharper rise from 68 to 79 percent (Richmond, Robinson, & Sachs-Israel, 2008). Thus, we focused on students from grades four to twelve to foster their literary progress as well. This study included 58 students who were also orphans in Kihesa-Iringa, Tanzania. By creating a Coalition of Children's Book Authors, we established a common ground for global literacy in the form of an NGO. However, the complication in literacy levels exists due to the digital-divide challenges coupled with the expense and delay of material delivered to Africa from the United States. Thankfully, our concern has succeeded to have influence even through the digital divide posed several objectives. Our course of action included a comprehensive plan to reach the 58 orphans, train their leaders, and create interactive learning modules. Thus, our contribution to the literature has reacted to the needs of an African community that could use help in not only literacy but also literacy-leadership communication and knowledge-management.

Keywords: Education, literacy, Tanzania, English language, Covid-19.

INTRODUCTION

There is growing interest in non-governmental organizations (NGOs), which encompass any "voluntary group or institution with a social mission" operating in an area separate from the government. This is evident in the fact that interventions from non-governmental organizations that focus on children's literature have helped boost the English literacy rates of children in disadvantaged areas. "Child literacy is often taken for granted, but around the world, millions are growing up without

the ability to read or write. What many do not realize is that literacy has a direct effect on poverty. According to a study conducted by the United Nations Scientific and Cultural Organization, there are links between illiteracy and higher unemployment" (Fernandez, 2019, p.1). Fernandez (2019) captured the essence of three primary NGOs:

- ✓ **Room to Read:** Room to Read is an NGO founded in 1998 that began its work in Nepal. Room to Read's vision is to improve literacy and access to literature in low-income communities, with a special focus on gender equality in education. The NGO has now spread all over Southeast Asia and Africa and has benefited around 16.6 million children worldwide. The NGO has distributed 24.1 million books, trained 15,285 librarians and teachers, and has partnered with 30,337 schools to implement its literacy program.
- ✓ **World Literacy Foundation:** The World Literacy Foundation was founded in 2003 with the guiding mission to provide books, tutoring, and literacy tools to children in communities that otherwise would not have access to these resources. WLF began transporting books to Africa in 2005 and shortly after developed low-cost eBooks that could be distributed in local languages. In 2016 WLF designed and implemented "Sun Books," which are solar powered tablets that bring educational books to classrooms in Uganda without electricity or the internet. WLF has been active in more than 93 countries, has provided access to literacy resources to 250,101 children, and last year alone reached more than 350,000 children and adolescents.
- ✓ **Pratham:** Pratham was founded in 1995 in Mumbai, India with the goal of having "every child in school and learning well." Pratham is one of the largest NGOs in India, operating in 21 out of 29 Indian states and with volunteers in 300,000 Indian villages. Its mission is to improve literacy and the quality of education in India by supplementing government efforts and supporting teachers and parents. Pratham's lead program, Read India, was launched in 2007 and has reached more than 30 million children. The program also provided training for around 61,000 teachers to improve literacy all across the country.

Although this is an important contribution to literacy improvement, there are unanswered questions and reasons in which these unanswered questions are critical. "As necessary as reading is to the success of a child—and entire nations—many low-income countries overlook the fundamental duty of their school systems to produce readers (Amber & Peter, 2011, p. 66). According to Fernandez (2019), "There are still 124 million children and adolescents that are not enrolled in school and one in four children in developing countries is illiterate."

The purpose of this paper is to provide an indicative connotation on how small groups of authors and individuals that are not part of the government can have an impact on the improvement of literacy effort in underdeveloped countries. For example, in Tanzania, Eastern Africa, specifically, literacy in English helps its orphans conduct higher level thinking while developing knowledge in a language usually used primarily in most countries. Thus, we found a way to help 58 orphans, ranging in ages 4 to 16, access a higher standard of education and an increased rate of success in their future working lives. By providing access to English, children's books specifically from authors around the globe, along with supplementary materials that complement the books gave the Tanzania orphans and surrounding community the chance to develop centers such as libraries and classrooms that helped engage children from underdeveloped countries to learn and grow in their knowledge of the English language more effectively. We published the names and ages of these children in the preface of our own authored books to ensure that people are aware of the need for the improvement of literacy. We then solicited several authors who sent their own books to Tanzania. Some authors read our books using social media platforms such as LinkedIn, and others are continuing to contribute. For example, a leading author joined our cause in 2023. We recently onboarded an author in London that will provide an array of children's books to the orphanage. The author's name is Rayner Tapia, and her shipment will include books from her series "The Adventures of Tom McGuire." This philanthropic

accomplishment will be the showcase of our advanced literary effort in 2023 as we continue to bring on more children's book authors to support our main cause—the Coalition of Children's Book Authors, a non-governmental organization (NGO) founded by Dr. Michael Provitera to support the orphans of Tanzania, Eastern Africa.

In our research effort to help the orphanage prosper, we gathered non-solicited communication from Majaliwa Mbogella, the Chairperson & Founder of the Children Care Development Organization (CCDO). In one form of communication published on the social media sites of LinkedIn and Facebook, Majaliwa indicated that the orphanage deeply appreciates humanitarian efforts to support the literary community of not only the orphanage in Tanzania, Eastern Africa, but also the surrounding community of Iringa Municipality in the Iringa Region of Tanzania.

Thus, the purpose of this paper is to explore how Tanzanian children, orphans specifically, utilize children's storybooks from the United States to help them grow effectively and efficiently into knowledgeable and productive adults. NGOs can enhance English knowledge through many facets such as author-readings, storytelling, crossword puzzles, teaching modules, videos, and other learning modes. An example of a strong NGO that utilizes these modes of learning habitually is the National Geographic.

> The National Geographic is where education meets exploration. We are transforming the learning experience for young people and the educators who reach them with the tools, resources, and support they need to feed their curiosity and become the explorers of tomorrow. Through immersive experiences, interactive lesson plans, maps, and other free resources – there are endless ways to learn with National Geographic (https://www.nationalgeographic.org/society/education-resources/).

The structure of the paper is based upon a qualitative study that answers the research question and includes an interview with the founder of the Coalition of Children's Book Authors, comments from the founder and chair of the orphanage, methods, discussion, and the results of our study, followed by suggestions for further research, and a conclusion.

This research question in which this study aimed to answer is:

How have children's books from international sources affected Tanzanian orphans' development of learning the English language from a literacy standpoint?

When we created the Coalition of Children's Book Authors, we began sending books to Tanzania to help them build their small library, which has since grown from our first shipment and communication with the orphanage. We have pictures of the library from the leaders of the orphanage with our books on the shelf and their children reading them. This literacy project truly has enriched the lives of orphans in Tanzania. We not only sent books that we authored ourselves, but from others too. Then we dived deeper into the true effect of our advances to increase literacy levels, which proved very beneficial to the orphans and the surrounding community of approximately 350 people. Some scholars may question why we chose to reach out to Tanzania, Eastern Africa out of all places. The leaders of the orphanage first reached out to Dr. Michael Provitera on social media in response to his motivation book for adults. After Dr. Provitera explained how the book and workbook could enhance the leadership skills of the Orphanage executives, we noticed that there was an established need for children's literacy development expressed by the founder Majaliwa. Being that Tanzania is an underdeveloped area of Africa, we reached as many people as possible with a strong focus on the original 58 orphans. Sending books had a vast effect on their education, since materials regarding literacy are relatively inaccessible for them. Realizing this, we sent them much more than books. From pencils and supplies to stuffed animals, we reached their hearts and souls. Thus, our original quest was to develop the hearts and minds of these orphans through books, but we also found a different type of connection that needed nurturing and an abundance of love and compassion.

This project not only provided these orphans with English media as an established role of NGOs—we began furthering literacy from the resources offered to less developed areas and demonstrated how the existence of an NGO affects children's literacy from the learning process to building collaboration across continents. When we read an entire book to the orphans via social media during the COVID-19 pandemic, while they were on lockdown, the students felt a sense of nurturing and special attention. We then received information that the leaders at the orphanage in Tanzania are building the Michael Provitera library. The leaders also indicated that the books were indeed sent to them, and that this new library expansion would reach an entire community benefiting over 350 people overall.

The major findings of this study yield substantial success in learning English by utilizing multi-modality learning, communication with the members of the NGO, and the techniques used by the orphanage to implement English, when faced with the resource-barren conditions of educational levels in Tanzania. Our research revealed a positive correlation between the implementation of NGOs and the Tanzanian orphan community, influencing their literary skills positively from the materials we have provided them. As we further our research, we are weighing the various options of how best to offer English literary materials to disadvantaged children and their communities. Thus, the effects of different types of interaction on learning achievement, satisfaction, and participation in video or web-based instruction helped not only during the COVID-19 crisis but well before that problem existed. We felt that we had an opportunity to make an impact on the orphans and surrounding community using web-based instruction, and we were able to make that possible. Jung, Choi, Lim, and Leem (2002) found that the effects of different types of interaction on a learning achievement, satisfaction, and participation in web-based instruction are tantamount to the success of learning and literacy development.

Literature Review

Although prior research has covered how children from struggling areas, such as Africa, utilize certain techniques to increase their literacy, it very rarely shows a connection between English children's books specifically and how books have strengthened children's knowledge of the language by using them. Prior research explores themes such as how NGOs impact literacies in developing schools, how English can be incorporated into the classrooms of underdeveloped countries, and how books can strengthen children's literacies in developing countries, but usually only in their native tongues. This indicates a need for more research veered towards the role of foreign NGOs in offering English media specifically, not just the furthering of children's literacy development in their own languages.

It is undeniable that non-governmental organizations (NGOs) have a substantial part to play in offering literary services to children and their communities with little to no access to educational materials. Education and NGOs, according to Lorraine Pe Symaco, (2016), in assisting governments for development has been highlighted in past literature (Edwards & Hulme, 1996; 1998; Zaidi, 1999; Rose, 2009; Hicks, 2014), much to the ideal that NGOs, given their perceived altruistic intentions, can provide the needed 'complementing' projects that are otherwise compromised in inefficient and ineffective governments.

Anyanzo (2017) explored how contributions by various agencies support the literacy of Tanzanian school children when their learning opportunities are usually close to none, due to the poor economic conditions that exist in their area. He examined a multitude of corporate and non-governmental organizations that opened opportunities to school children with literacy projects like providing books in the children's various native languages, constructing schools and libraries, and various involvement in the community to engage primary school children, and therefore, improve their quality of education. Other literary projects that established libraries such as the RTR program and the Tusome Vitabu Project "offered more opportunities for readership, hence, inculcated the culture of reading for both pleasure and information among children" (Anyanzo, 2017, p. 21). This study asserts that intervention by NGOs in these resource-barren countries is not only essential for providing literary materials for its young students, but also in sustaining pre-existing literacy practices and turning activities like reading into a healthy educational habit.

Much like the goals and incentives of the NGOs mentioned by Anyanzo (2017), other studies highlight the importance of having more interactive NGOs with engaging literacy projects that reach out globally to children to increase their literacy levels. Bloch (2014) expands upon the prior research by using an independent development organization called The Project for the Study of Alternative Education in South Africa (PRAESA), which worked toward providing learning opportunities by storytelling for young children in South Africa. This method embraces community, with PRAESA's team of literacy activists working "to set up and support a network of reading clubs who engage communities in children's literacy development" (Bloch, 2014, p. 158). This furthers the idea that storytelling, as a form of learning literacy, can be used in a way that children not only can develop their literacy skills, but also cultivate enjoyment in reading. Scholars also found that book reading becomes an up close and personal experience and yields a positive experience in learning language (Dickinson, Griffith, Golinkoff, & Hirsh-Pasek, 2012).

However, an interesting concept that surfaces in this research is the fact that this organization incorporates both books in the children's African home languages, but also in English—thus, attempting to broaden global literacy skills. PRAESA works to "promote mother tongue based bilingual approaches to language use, in formal and non-formal education" (Bloch, 2014, p. 157). Throughout their work, Bloch's team of educators and authors suggest that English, when paired with a child's knowledge of their first speaking language, results in a higher literary understanding when utilized in projects and activities. Therefore, there exists a need for more research detailing how specifically English media from NGOs helps develop literacy in the language for children in developing areas, not just in their own various mother tongues.

When students are introduced to a form of secondary-language teaching and learning in low-access classrooms, English is made a priority to utilize for communication, thus expanding both knowledge and use of literacy. Prior research has focused on the importance of English as a foreign language for students, and the techniques in which teachers can enhance the use of language across continents effectively. Malini and Sankaran (2019) specifically analyzed how students and teachers alike in a Rohingya school perceive the process of learning English and its literacies. Though this research did not use techniques focusing on reading English stories, the skills obtained by the students were the same: vocabulary, reading comprehension, and pronunciation. Detailed observations of techniques for these students to learn English included "activating their background knowledge to make sense of what they read and hear," and utilizing a practice usually not used in mainstream English classes; using a known second language Bahasa Melayu to communicate and guide English lessons (Malini & Sankaran, 2019, p. 129). Throughout the process, the student collaboration seen from utilizing this language to learn English is what really helped cement their English teachings that they can then utilize throughout their lives. The theme of practicing teamwork through another language to understand English is the essence of another case study from Makoe and McKinney (2009), where one student's peer techniques were analyzed in how she learned English in a multilingual South African primary school. Tumi, a seven-year-old girl, used her known second language, Sepedi, to help her teacher guide lessons, and for the classroom to understand specific English words. This study highlights that by noting "her strategic choice of a different linguistic code from the English used by her teacher, served to enhance the educational outcomes" (Makoe & McKinney, 2009, p. 87). With Tumi's help, her classmates were brought together as students, all well-versed in Sepedi, proving that the choice of implementing this language in lessons helps them attain heightened literacy in the English language. Thus, prior research has indicated that the English learning experience for students is possible in the classroom setting with little to no knowledge of the language—but there still exists a need for more research focusing on orphans, rather than enrolled schoolchildren, and their unique conditions and communities, specifically with learning English.

Trends in past research either depict libraries in classrooms offering literacy development in the children's own languages, or detail on the conditions surrounding teaching English as a whole. Most importantly, the research shows that how educating and training teachers from these areas in English

is just as important as it is for its children learning it. However, studies in the future need to explore how orphans and their communities utilize different forms of learning and strategies to understand English and its literacy. By focusing on the orphanage and its related school, which are the same, future research should focus on how disadvantaged communities learn and thrive (Philip, 2017). Specifically, NGOs and their role in facilitating English media to these areas and the affect it has on how they learn is also an effective area to research in the future. Our study fills this gap of research by offering a focus on a specific orphanage in Tanzania, and how an NGO from the United States of America affect that unique community, in offering children's books for its orphans and complementary study material. Since Tanzania, in general, is not very well equipped with literary materials and resources to learn English, our study aims to investigate how English media can shape these orphans' learning process and use their newfound literary knowledge to ensure heightened educational success by using the English language in their future.

METHOD

Model of Research

Our research question consisted of the following:

"How have children's books from international areas affected Tanzanian orphans' development of learning the English language and its literacies?"

In selecting our model of research, we read the work of Buckley and Chiang (1976), who define research methodology as "a strategy or architectural design by which the researcher maps out an approach to problem-finding or problem-solving." We felt that this method of research was better used in business. We then reviewed research posed by Crotty (1998), who argues that research methodology is a comprehensive strategy "that silhouettes our choice and use of specific methods relating them to the anticipated outcomes, but the choice of research methodology is based upon the type and features of the research problem." This was too cumbersome for us to determine its use for our study. Qualitative research methodology is considered to be suitable when the researcher or the investigator either investigates new field of study or intends to ascertain and theorize prominent issues (Corbin & Strauss, 2008; Creswell, 2007).

After a review of the most appropriate qualitative model, we decided that our research consisted of a semi-structured interview which was in-depth, and our respondents answered preset open-ended questions. Semi-structured, in-depth interviews are utilized extensively as an interviewing format possibly with an individual or sometimes even with a group (Corbin, 2007). Thus, our semi-structured interview was conducted once only, with an individual and cover the duration of 30 min to more than an hour. This method of research is well noted in the qualitative studies by DiCicco-Bloom and Crabtree (2006). Thus, Janet Provitera, the interviewer, used the semi-structured interview process guide, which is a schematic presentation of questions to be explored and answered by interviewing Dr. Michael Provitera, the Founder of the Coalition of Children's Book Authors.

To achieve the optimum use of interview time, Janet used an interview guide which served a useful purpose of exploring each question from Dr. Michael Provitera more systematically and comprehensively as well as to keep the interview focused on the desired line of action (DiCicco-Bloom & Crabtree, 2006). The questions in the interview guide comprised of the core question and many associated questions related to the central question, which in turn, improved not only due diligence but also allowed room for personal reflection by both the interviewer and interviewee (Janet and Michael). Responses of the questions were captured using a taped interview session (DiCicco-Bloom, 2006), and were captured with twelve pages of transcribed, typed out notation. Research contends that verbal prompts from taped interviews enables the transcriptionist to generate "verbatim transcript" of the interview (DiCicco-Bloom, 2006).

The coded transcript began developing questions' themes around the following concepts in order:
Cultural Background of Michael Provitera

Academic Experience
Experience with Children
Determination
Connection
Collaboration
Communication
Genuine Generosity
Variety of Learning
Struggles of Underdevelopment
Learning Literacies
Necessity of English

Based on the transcript, the cultural norms of the interviewee coupled with the questions led to the codes indicated in the findings section below.

Data Collection Tool

Our data collection tool consisted of predetermined questions created by Janet, the interviewer. The questions were then approved for validity by her literature professor to utilize in this study. A scheduled appointment for sixty minutes was created with the interviewee, Dr. Michael Provitera. The face-to-face interview took 20 minutes and 38 seconds using phone dictation and a coded transcript. "Qualitative coding is a process of systematically categorizing excerpts in your qualitative data in order to find themes and patterns. It enables you to take unstructured or semi-structured data such as transcripts from in-depth interviews or focus groups and structure it into themes and patterns for analysis," (Saldana, 2009; Given, 2008; Clarke & Braun, 2013). The interview date was on October, 24, 2021, and was conducted in Power's Hall, Barry University, Miami Shores, Florida, USA. Michael Provitera was the chosen interviewee because he is an author of children's books and a professor of organizational behavior. He was also selected because of his expertise as founder of the Coalition for Children's Book Authors. He provided his disclosed knowledge gained not only by sending his books to the Tanzania Orphanage, but also by sending other authored books by coalition members. We wanted to investigate the effect that he had, and continues to have, on the Tanzania orphans' literacy skills.

In the interview, Michael was asked basic demographic questions first along with ones inquiring his educational skills, then we dove deeper into its relationship to his Tanzanian research project later. As the interview progressed, questions evolved into topics exploring how Michael perceives that the orphans have improved in English, how and why he sends books to them and their area, and more insightful questions toward the end on how he sees his project expanding in the future and what that means for providing Tanzanians more resources to enhance their English literacy. Through the interview, we hoped to gain a sense of knowledge on how Michael's NGO has changed the way these orphans learn English, and the techniques in which it has done so. Selected questions were:

1. What influenced you to send over your children's books to Tanzania out of all places?

2. How do you perceive the progress of the literacies of the Tanzanian orphans you sent books to now, versus the time you started?

3. Is it true that the orphanage leaders built a library in your name in Tanzania? If so, how does that escalate their learning of the English language even further?

4. So, speaking of communication, what challenges have you faced when communicating with the heads of the Children Care Development Organization (CCDO) in Tanzania?

5. So, speaking about LinkedIn and the Coalition of Children's Book Authors, how has leading that effort helped you become more enlightened about the conditions in Tanzania?

6. Knowing that Tanzania is an undeveloped and uneducated area, how does that factor into the importance of sending over your books there?

7. Have the leaders of the children in Tanzania ever notified you about the children's progress, the orphans' growth, and comfortability with English?

8. How do you feel that the orphans will benefit in the future and in their work lives from reading your children's books?

9. Why do you believe that kids from undeveloped areas like Tanzania should be provided with English media, like books to enhance their understanding of the English language?

10. Do you feel that providing audio of the book in the form of reading it to them benefits them more than them reading it alone?

11. Do you think that you can expand or improve the literacy program that you developed in Tanzania?

12. What is your vision of the Coalition of Children's Book Authors, and could you expand this program in the future?

Analysis Techniques

Qualitative techniques were used in the analysis. The analysis technique used in the research was based upon a citation of all questions and answers with a side column that searched for themes based upon reflexivity and alignments. Blair (2015, p. 1) determined that the best coding technique reflects the research. For example, Blair's exploration found there was no clear-cut 'best' option but that the data coding techniques needed to be reflexively aligned to meet the specific needs of the project. We were methodically sensitive to the data collection and ensured that we captured every word or inflection as we conducted in the interview. As Blair (2015) contends, this type of reflection suggests that, when coding qualitative data, researchers should be methodologically thoughtful when they attempt to apply any data coding technique; that they do not assume pre-established tools are aligned to their particular paradigm; and that they consider combining and refining established techniques as a means to define their own specific codes. We followed Blair's advice accordingly.

FINDINGS

The qualitative study analyzed transcripts using the following *codes*:

- *variety of learning*
- *connection*
- *collaboration*
- *communication*
- *struggles of underdevelopment*
- *necessity of English.*

Based upon the questions developed above and the interviewee, Michael Provitera, we found that there was a plethora of data collected. For example, after a descriptive qualification of Michael, we delved into the questions. Below is a sample of a question and answer between the encoder and decoder.

What influenced you to send over your children's books to Tanzania out of all places?

Excellent question. Thank you, Janet. Well, it started out as a LinkedIn connection in which I had someone ask me about my motivation book. So, I sent my motivation book, and I sent my free workbook and the Tanzania officials at the orphanage were using it to see how it could

> *help their community. Once it helped them to a certain extent, they were telling me that in their area, there is a lot of poverty and it is not accepted as well because there are other problems like AIDS, and starvation, and poor water and sewage, things like that. So, I said, well maybe there is another way I could help. I have a children's book and perhaps I could send books to the orphanage, and I could send a coloring book, teaching notes, and classroom exercises. So, they were very excited about that. And that is how it all started. So, I have a Coalition of Children's Book Authors, and we sent over five hundred books to Tanzania, Eastern Africa.*

We investigated how Michael utilized his prestige, writing, and connections within his coalition to conduct his projects in Tanzania, and how that communication benefitted the Tanzanian orphans in not only learning English but building collaboration and engagement. In analyzing how Michael's commitment to carrying out his research project and the generosity of his service contributed towards an elevated learning environment for the Tanzanian children, we noticed that repeated phrases emerged when Dr. Provitera discussed communication with his coalition and Tanzania, the lack of quality and quantity of literacy based upon the conditions in that area, and whenever he mentioned sending over different literary resources as a strategy to increase literary knowledge among the orphans. The major findings indicate that children's books from international areas help Tanzanian orphans improve in learning English by giving them multiple modes of learning, a stronger connection with American authors and the people portrayed in the stories, a stronger knowledge of the English language, and access to educational materials they would not have been able to gather for themselves alone.

Relating to the effect of international children's books and media for children in Tanzania, it is evident that a variety of literary resources, geared to engage students, helps children learn English at a higher level. Throughout the interview, Michael explained how he not only focuses on sending his children's books to Tanzania, but also on "different ways for them to engage" like workbooks, author-reading of chapters on video, educational exercises, and crossword puzzles that he has taken the time to create himself to pair with the readings. Michael also mentioned in the interview how most students in Tanzania "are illiterate" and "can't read a sign that may lead them to doctors to ascertain their medication," meaning these children need resources that can not only stimulate their minds, but also improve their quality of life and their safety. Visual stimulation and activities, such as completing a crossword puzzle related to a book after it is read, helped the orphans learn new English words found in Michael's books—allowing them to strengthen their literacy in the English language in different and new ways.

We found that the variety of teaching modalities can also refer to an array of topics to provide a unique reading form for the orphans. In multiple occasions throughout the interview, Michael reaffirms the importance of having a coalition of children's authors to aid him in his efforts to send books to Africa. Michael explained that his own storytelling is aimed to help whoever reads his work "to be more creative and thinking about entrepreneurship and all the concepts of management, leadership, and especially, motivation." Meanwhile, different members in his coalition sent books over to Tanzania covering different informative topics such as, but not limited to, dyslexia and other attention deficit disorders, developing the orphans' literary skills in different areas of focus. This variation of topics not only provides the orphans in Tanzania with the actual English words to grasp throughout their reading, but also creates a better sense of basic vocabulary and understanding overall. Mutua (2023) found that the acquisition and retention of vocabulary is an important step in attaining the proficiency of the English Language as a second language. And as Michael mentions, their works embedded with this vocabulary "give them the information they need to be more successful in their life endeavors." Michael's work to diversify the subject matter from the literary resources through multiple modalities proves efficient and effective in developing and strengthening English literacy in Tanzania's orphans.

We observed that direct and unwavering communication with the providers of the literary materials that the Tanzanian orphans receive helps form an essential connection that not only fosters a higher

understanding of English through exposure to its speakers, but also helps create a more personalized learning experience—since each of the 58 orphans are provided with their own literature and complementary material. Throughout multiple spots in the interview, Michael mentioned how he maintains a strong sense of collaboration with the members of his coalition, and the representatives and children of the Tanzanian orphanage that he provides the books to. In several instances, Michael has conducted seminars in which the audience either directly or indirectly collaborates with each student by sending them a colorful note or creating a video with words of love and confidence in their success. This deliberate process is one where it makes every individual orphan receiving these materials feel special, when there is very little else done to help them feel special in their daily lives. The existence of communication throughout his project is so strong that whenever anyone in the community wants to send books to the Tanzanian children for Michael's Coalition, he would "put the names of each orphan, their gender, and their age directly in each book" so that the sender of any book knows more about the exact child's age and gender in which they are helping out. Also, in the interview, Michael mentioned how he offers personal connection through his YouTube videos—giving the students "a sort of a comradery of a professor, an author, and motivational speaker who took his time out to directly read the book, chapter by chapter, for free." When communicating the best that we can where face-to-face meetings are rare, we found social media to be the only successful outlet. While face-to-face communication allows the process to become more personal, the alternative video and reading to an audience adds a television-type touch to the communication in a world where electronic communication veers towards becoming the norm. As the children of the orphanage began to realize that Michael, and the volunteers of the coalition, are not just complete strangers offering them literary resources, the project does not feel like an unknown international entity offering them help anymore, but rather fosters companionship and connection—making their experiential learning of English one they will remember for a lifetime. Thus, it is evident that communication is an essential part of learning English, and its incorporation in several aspects of the process of understanding the language yields many literary benefits for the orphans.

We must convey that the poor conditions that Tanzania, and its children, face play a key role in how they learn and apply English and its literacies throughout their lives. During the interview with Michael, the topic he mentioned throughout most of his answers were the ones that mentioned the conditions in an undeveloped area like Eastern Africa, including problems like poverty, a lack of funds, insufficient healthcare, and relatively no access to books, or any educational and literary materials at all. COVID-19 has only exasperated their stock of learning materials even further, where becoming digitalized and readily supplied with technology was a necessity to learn in developed countries. Though, in an under-developed country like Tanzania, its schools and orphanages were simply not able to be equipped with the technology needed to learn so quickly. According to Upor (2023), who found examples from language learning in Tanzania, revealed challenges of the unbalanced technology ecosystem for language teaching and lessons that can be drawn from the experience. And as technology does not seem to become implemented in the area anytime soon, books have an elevated necessity to be placed in the hands of learners that may last well into the future. Unfortunately, these physical factors and digital discrepancies result in a lot of students in the Tanzanian area not only being illiterate, but in some cases, faced with danger when not being able to read signs on the streets or travel and obtain needed medicine and groceries. Michael, in one portion of the interview, specifically addressed these problems for the orphans, including the fact that Majaliwa, the founder of the orphanage, expressed these real-life concerns to him explicitly. Thus, when Michael and his coalition sent over books and other various literary resources, the Tanzanian orphanage created a small library in his name to not only ensure the books are in safekeeping, but also to create and utilize their own version of a library for studying, where few libraries are found there. The necessity of having these books in their hands also comes from the fact that English is used very widely across almost all nations as a primary language, and learning it is usually a requirement for these children when they pursue their education, making it important to not only learn but also implement the knowledge gained in their futures.

In the interview, Michael mentioned that the orphanage he sends books to contain students that are "deprived of having the money and the resources" to learn. Therefore, with the books Michael and his coalition send to, "the orphanage and the community … are utilizing the library and its books," giving the orphans, and the surrounding community, crucial information so that "when the literacy increases for each individual, this knowledge will actually save lives." Thus, by using simple children's book stories and the knowledge gained from them, these Tanzanian orphans can not only strengthen their connection with English, but also use the language to learn important concepts to foster their creativity and the level of success in their working lives. Therefore, we found that when the necessity of receiving literary materials is incorporated into the learning process, Tanzanian children utilize what NGOs offer in unique ways that essentially work to boost English literacy globally.

DISCUSSION, CONCLUSION, and SUGGESTIONS

Books from international NGOs not only help Tanzanian children improve in their learning of English, but also give them the skills they need to succeed in their lives, making the literary knowledge they gain last for a lifetime. With the challenges Tanzanian children and their communities face due to their location and environment, the existence of educational materials such as books, workbooks, and even basic stationery such as pencils, crayons, and pens make a positive difference in how they learn English. As their knowledge of English improves, the children are better equipped to learn through international books that they would otherwise not have. Thus, these children can utilize their newfound intelligence and literary skills through the educational endeavors that they may pursue in their futures, where English is often needed to learn and grow. English language skills can also cross into other areas of expertise, making it an additional benefit for the orphans to learn when going into any industry. An interesting find from an aviation program provides evidence of the impact of the English language. "Proficiency in English has become the standard language in the international aviation industry. To avoid accidents, all aviation personnel need to communicate in English," (Mahmood, Saad, & Nur, 2003). Thus, the communication skills of the Tanzania orphans and surrounding community may be enhanced during reading and study of the English language.

Reading storybooks to children maximizes the kinds of experiences that predict language learning and may even exceed the power of oral conversations at times. There are at least three ways in which book reading influences language learning. According to Dickinson, Griffith, Golinkoff, and Hirsh-Pasek, (2012), reading storybooks offers children the opportunity to hear new vocabulary items embedded in varied grammatical sentences. Books written for children use well-formed, relatively short sentences that are rich in varied vocabulary. The second way in which book reading enriches children's lives and language is that it promotes joint attention and interest. Children are able to draw an adult's attention to interesting pictures using a broad range of cues including gestures, sounds, and words. Third, book reading helps children learn language because it requires the participants to be active and engage in responsive interactions about word meanings. Thus, the children of Tanzania are able to benefit in the same way from their use of English children's books and may implement these ways of learning the language in the process.

These benefits from learning English shed light to the fact that future research in this area is important because Tanzanians are not the only ones who can benefit from having an improved English literacy. There are many other different undeveloped areas throughout the globe that have similar problems of not being able to afford simple educational materials necessary for their students to learn both effectively and efficiently. In some cases, it is not the children's fault that there are literacy problems in their community. Mutua (2023) found that parents from low-income households in Kenya only afford to enroll their children in public schools. The author indicated that most parents from such households lack time to show affection to their children, which may influence their verbal acquisition process at home and in school. Furthermore, the author found that learners' performance suffers as a result of insufficient supervision, making it harder to acquire appropriate English vocabulary. This

adds to the stress of the need develop a strong or stable literacy in any under-developed area where this happens so that its children are able to prosper.

We also would like to present the value of teachers and the help that they offer the many children attempting to develop their literacy skills, since it is them that put in most of the time to help a child learn literacy apart from their parents. An interesting study focused on teachers and teacher motivation as a way of enhancing learning of children. A study discovered that the issue of teacher absenteeism and poor learning outcomes can be resolved by providing extrinsic motivation, such as a financial incentive for teachers based on their teaching effort and appreciating the intrinsic motivation at the same time. The study recommends that the government should prioritize teacher motivation as suggested by Maslow's hierarchy of needs theory (Juma and Stonier, 2023). From governments around the world, to leaders like the ones in the Tanzanian orphanage, to parents, and to teachers, everyone has to be involved in a child's educational pursuit for them to flourish.

Conclusion

The Tanzania Orphan Literacy Project set a common ground for educators who met virtually and maintained a cohesive relationship that is still viable and prosperous today. We addressed a complication that occurs not only in the digital divide of literacy, but also in the underdeveloped countries that exist—not to mention the effects of COVID-19 and the lockdown that did not let the orphans go to school or leave the orphanage for more than a year. Thus, our concern raised the bar in global literacy with a method of increasing literacy by sending books and other resources from multiple authors worldwide. We encourage more scholars to step up and help the underdeveloped countries to become more aware of the English language so that they can learn and grow similar to the developed countries.

Suggestions for Future Research

Our suggestions for further research in this area of literacy and underdeveloped countries would first include the investigation of diversity, equity, and inclusion. For example, our course of action is simple. Seek volunteers, in our case children's book authors, but this can be expanded to reading professors and educators that can contribute to the cause of underdeveloped country literacy. We suggest that researchers find a need and meet that need by incorporating diversity, equity, and inclusiveness throughout their profession. The wide diversity among the orphan children, inadequate equity, and lack of inclusiveness in world literature led us to step up to the challenge of teaching across continents via social media, mail, and publishing sources such as Amazon. Our contribution to world literacy is encapsulated in this article and we encourage more people to reach out and help the Tanzanian Orphans. Another suggestion we would include for future research is to clearly establish what digital learning should encompass and provide for educational institutions and the future of schools as we veer towards technology to meet our learning needs. We believe that there are too many versions mentioned of how digital learning occurs in societies, that it becomes unknown what exactly digital learning is defined as. For instance, Marin and Castaneda (2023) found an array of terms such as remote learning, distance learning, open learning, e-learning, flexible learning, hybrid learning, blended learning, web-based learning, online learning, mobile learning, and technology-enhanced learning—all terminologies that may be confusing for many readers to understand. These authors provided their own solution to this in their book titled "Open, Distance, and Digital Education" (Marin and Castaneda, 2023). Marin and Castaneda (2023) condensed this plethora of terms into just three: open and distance education to clearly mark the historical origin of recent online education, and digital education to capture newer manifestations of teaching and learning with digital media in the process of the digital transformation of educational institutions. While Tanzania, Eastern Africa might not be ready for technological implementations like digital learning, we want to point out that this may be the direction of the future of learning modalities and that it is important to qualify exactly what it means. The last suggestion for future research is to create projects like the Coalition of Children's Book Authors or implement this research to inspire others to strengthen literacy in the English language for undeveloped areas and children globally.

Limitations of the Study

A lack of technology in the area of Tanzania prevented us from conducting an online interview with the leaders there, while a lack of resources in the area held us back from meeting the leaders for a physical interview. Therefore, any communication between the Coalition of Children Book Authors and the Tanzania leaders had to be channeled digitally through email and social media.

Ethics and Conflict of Interest

We declare that we, as researchers, acted in accordance with ethical principles throughout the research process. Since we have multiple authors, we declare that there is no conflict of interest between the researchers. For example, Janet began this project as a term paper for a professor in an English course at a private college and the professor did not want to be recognized, although we do acknowledge her guidance and respect her contribution and expertise. Michael is the founder of the Coalition of Children's Book Authors and continues to work closely with the Tanzania orphans and leadership in Africa. Mostafa, a well-recognized researcher, managed the production and the publishing process. Thus, ethical principles were followed throughout the research process. No information was solicited from the Tanzania founders and leaders through interviewing, and the only information that they provided for use in this study was through the communication of thank you notes and their recognition as we had a working relationship. The children of the orphanage were not asked any questions and only received the books, supplies, and other things that they can use for fun and learning. We did receive a large number of pictures of the children, and this was also an indication of the satisfaction that can only be seen and not recorded in our research. Photos can be available by request through the authors. The photos came to our research investigation free of copyright and are part of the public domain.

REFERENCES

Blair, E. (2015). A reflexive exploration of two qualitative data coding techniques. *Journal of Methods and Measurement in the Social Sciences*, *6*(1), 14-29.

Bloch, C. (2014). The project for the study of alternative education in South Africa (PRAESA). *Bookbird: A Journal of International Children's Literature*, *52*(4), 156-160. https://doi.org/10.1353/bkb.2014.0156

Buckley, J. W., & Chiang, H. F. (1976). *Research methodology and business decisions*. Canada: Natl Assoc of Accat

Clarke, V., & Braun, V. (2013). Successful qualitative research: A practical guide for beginners. *Successful qualitative research*, 1-400. Sage.

Corbin, J., & Strauss, A. (2008). *Basics of qualitative research: Techniques and procedures for developing grounded theory*. 3rd edition. Thousand Oaks, California: Sage Publications.

Creswell, J. W. (2007). *Qualitative inquiry and research design: Choosing among five approaches: International student edition*. Thousand Oaks, California: Sage Publications.

Crotty, M. J. (1998). The foundations of social research: Meaning and perspective in the research process. *The foundations of social research*, 1-256. Thousand Oaks, California: Sage.

DiCicco-Bloom, B., & Crabtree, B. F. (2006). The qualitative research interview. *Medical education*, *40*(4), 314-321.

Dickinson, D. K., Griffith, J. A., Golinkoff, R. M., & Hirsh-Pasek, K. (2012). How reading books fosters language development around the world. *Child Development Research*, Article ID 602807, 15 pages.

Edwards, M., & Hulme, D. (1996). Too close for comfort? The impact of official aid on nongovernmental organizations. *World development*, *24*(6), 961-973.

Edwards, M., & Hulme, D. (1998). Too close for comfort? The impact of official aid on nongovernmental organizations. *Current Issues in Comparative Education*, *1*(1), 1-21.

Fernandez, I. (2019). *3 NGOS improving child literacy across the globe*, Found on website on February 12, 2023, https://borgenproject.org/ngos-improving-child-literacy/

Given, L. M. (2008). *The Sage encyclopedia of qualitative research methods*. Swinburne University, Australia, Charles Sturt University, Australia: Sage.

Gove, A., & Cvelich, P. (2011). *Early reading: Igniting education for all. A report by the early grade learning community of practice*. RTI International: p. 66-72. https://eric.ed.gov/?id=ED520290

Hicks, R. (2014). *Education and poverty alleviation in Eastern Africa: The causal links*. In L.P. Symaco (Ed.) *Education, Poverty, Malnutrition and Famine*. London: Bloomsbury, pp. 15–38.

Juma, A. A., & Stonier, F. (2023). Teacher Absenteeism and Poor Learning Outcome in Tanzania: Rethinking an Incentive Scheme as a Strategic Solution to the Problem. *The African Review, 1(aop)*, 1-26. (published online ahead of print 2023). https://doi.org/10.1163/1821889x-bja10046

Jung, I., Choi, S., Lim, C., & Leem, J. (2002). Effects of different types of interaction on learning achievement, satisfaction and participation in web-based instruction. *Innovations in education and teaching international*, *39*(2), 153-162.

Makoe, P., & McKinney, C. (2009). Hybrid Discursive Practices in a South African Multilingual Primary Classroom: A Case Study. *English Teaching: Practice and Critique, 8*(2), 80-95.

Mahmood, A. S., Saad, N. S. M., & Nur, N. M. (2023). The Ups and Downs of Learning and Using English: Aviation Students' Voices. International Journal of Language Instruction, 2(1), 1-15. https://doi.org/10.54855/ijli.23211

Marín, V. I., & Castaneda, L. (2023). Developing digital literacy for teaching and learning. *Handbook of Open, Distance and Digital Education*, 1089.

Mutua, D. (2023). Influences of learning environment on English language vocabulary acquisition among learners in Kitui County, Kenya. Journal of Languages, Folklore and Ecology, 1(1). https://doi.org/10.58256/jlfe.v1i1.992

National Geographic Society is a 501 (C) (3) organization with Headquarters in 1145 17th Street NW Washington, DC 20036. Retrieved from https://www.nationalgeographic.org/society/education-resources/

Philip, A. J. (2017). The role of the corporate multilateral agencies in education: The case of literacy projects in Tanzania. *The Educational Review*, USA, 1(2), 17-25. http://dx.doi.org/10.26855/er.2017.02.001

Richmond, M., Robinson, C., & Sachs-Israel, M. (2014). *The global literacy challenge: A profile of youth and adult literacy at the midpoint of the United Nations Literacy Decade 2003-2012*. United Nations Educational Scientific and Cultural Organization. Accessed 18/05.

Rose, P. (2009). NGO provision of basic education: Alternative or complementary service delivery to support access to the excluded? *Compare, 39*(2), 219-233.

Pe Symaco, L. (2016). *Education and NGOs*, Bloomsbury Academic.

Saldana, J. (2009). *The coding manual for qualitative researchers*. Thousand Oaks, California: Sage.

Sankaran, K. V., Ganapathy, M., & Debbita Tan, A. L. (2019). EFL teaching and learning practices in the Rohingya classroom: A case study. *International Journal of Applied Linguistics & English Literature, 8*(2), 126-131. http://dx.doi.org/10.7575/aiac.ijalel.v.8n.2p.126.

Upor, R. A. (2023). *Adapting technology in language teaching and learning in Sub-Saharan Africa: Lessons from the Covid-19 Pandemic in Tanzania*. 1st Edition, Routledge Publications: New York, New York.

Zaidi, S. A. (1999). NGO failure and the need to bring back the state. *Journal of International Development, 11*(2), 259-271.

IOJPE

ISSN: 1300 – 915X
www.iojpe.org

International Online Journal of Primary Education *2023, volume 12, issue 1*

EFFECT OF TWO INSTRUCTIONAL STRATEGIES ON SPELLING PERFORMANCE OF PUPILS WITH LEARNING DISABILITIES IN IBADAN, NIGERIA

Kelechi Uchemadu LAZARUS
Ph.D., Department of Special Education, University of Ibadan, Oyo State, Nigeria
ORCID: https://orcid.org/0000-0001-8347-3206
ppadaeze@yahoo.com

Oloyede Ojo AUDU
Department of Special Education, University of Ibadan, Oyo State, Nigeria
ORCID: https://orcid.org/0000-0001-7499-8887
oloyedeojo07@gmail.com

Received: December 02, 2022 **Accepted:** February 15, 2023 **Published:** March 31, 2023

Suggested Citation:
Lazarus, K. U., & Audu, O. O. (2023). Effect of two instructional strategies on spelling performance of pupils with learning disabilities in Ibadan, Nigeria. *International Online Journal of Primary Education (IOJPE), 12*(1), 15-24. https://doi.org/10.55020/iojpe.1274830

Abstract

Spelling is a crucial skill for academic success however many pupils with learning disabilities lag behind in academic tasks because of poor spelling skills and its accompanying negative effects. Past studies on pupils with learning disabilities focused more on reading than on spelling skills. Thus, the objective of the study was to examine the core effects of visual imagery and cloze spelling instructional strategies on pupils with learning disabilities' performance in spelling. The pretest-posttest control group quasi-experimental design of 3 x 2 factorial matrix was adopted. Sixty pupils with learning disabilities (Male = 38, Female = 22, Mean age = 9.35) from three government-run primary schools were chosen using purposive sampling. Three instruments used were Pupil Rating Scale (Revised) (r = .76), Right Word Recognition (r = .91) and Pupils' Note Books on Dictated Words. Data were analysed using both descriptive and inferential statistics. The results showed that the core effect of treatment on the performance in spelling of pupils who experience disabilities in learning was significant $F_{(3,56)} = 2.085$. $p<.05$, $\eta^2 = .418$), but gender had no significant core effect. Therefore, teachers should employ the visual imagery and cloze spelling instructional strategies while teaching spelling to pupils with learning disabilities.

Keywords: Pupils with learning disabilities, visual imagery, cloze spelling strategy, gender, spelling skill.

INTRODUCTION

Spelling, an essential language skill, is one of the developmental processes necessary for effective communication. It is defined as the capacity to build words using letters in accordance with accepted usage. There's the possibility that the language skills are interconnected. Therefore, in order to develop proficiency in spelling, pupils must master certain skills in language, including the skills of phonology, morphology, visual memory, semantic relationship skills, and etymological (word origins) skills. By implication, the majority of the linguistic abilities required for reading development are also required for spelling growth (Van Staden, 2010; Treiman & Kessler, 2014; Adoniou, 2014).

Spelling can be used to actually complement the reading programme and competence in spelling is considered a prerequisite for proficiency in spoken and written communication. A pupil who has difficulty spelling words is likely to struggle with reading, and vice versa. The co-morbidity of spelling and reading difficulties in pupils with learning challenges is clear from this illustration and demonstrates the co-occurrence of spelling and reading problems in pupils with learning disabilities (Lazarus, 2016). Also, the ability to spell words is closely linked to written composition fluency during the writing process. Pupils who are proficient in spelling may not only produce good papers but also read written materials fluently. Likewise, pupils who lack strong spelling skills may find it difficult to become fluent and successful writers.

The ability to spell has an impact on a pupil's academic and social performance. Poor spellers make sloppy, error-filled compositions. Such compositions will depict semantic, lexical, and syntactic uncertainties, and will not allow for English unity and cohesiveness. Incorrect spelling can sometimes impair pupils' handwriting. In this instance, a poor speller may cancel and redo words and sentences, resulting in disorganized compositions. Good spelling, on the other hand, aids vocabulary growth, which improves reading comprehension. When composing reading texts, proficient spellers select high-quality words (Adoniou, 2016). This, in turn, leads to more effective communication, as well as better readers and writers. Poor spelling reflects how attentive an individual is to detail and how committed an individual is to producing high-quality work (Barker & Puente, 2013). Thus, teachers might construct a perception of the writers and their writings based on their spelling skills.

Low self-esteem may result from spelling difficulties. Pupils who have trouble spelling words tend to be silent in class needlessly, and in some situations, they are unable to express themselves orally or in writing. Consequently, academic performance in all areas of the school curriculum may be impacted. This circumstance may have long-term consequences for the pupils. For example, pupils who struggle with spelling may find it difficult to continue their schooling as well as find work and advance in their careers. Some applicants were not shortlisted due to bad spelling in their curriculum vitae and other application documents (which employers check in the course of a preliminary screening step). This led to the persons exhibiting self-deprecation, a lack of clear goals or values, and depression (Martin-Lacroux & Lacroux, 2017).

The irregular and inconsistent structure of spelling patterns in English words is one reason for the relatively high occurrence of learners with spelling issues, particularly among those with learning disabilities. There are 44 phonemes (sounds) represented by the English alphabet (that is, the 26 letters). In order to write effectively, these 26 letters provide a large number of letter combinations (6000-12,000 words) (Gentry, 2010). When pupils realise that the spelling of most words does not match the pronunciation pattern of the words, frustration sets in throughout the spelling process. As reported by Hamdi (2016), there were 54 mistakes of spelling in the 20 pupil essays reviewed, with 40.74 percent of the errors being formal in nature, 31.48 percent being related to word construction, 22.22 percent being related to word selection, and 7.40 percent being related to semantics. This means that the majority of spelling mistakes made by pupils learning English as a second language were formal mistakes.

Pupils who have distinct learning impairments in the academic area of spelling perform poorly in school (Lazarus & Ogunsola, 2016). These authors confirmed the link between reading, writing, and spelling abilities and stated that these fundamental skills must be improved in order to increase pupils' overall academic accomplishment. A pupil with bad spelling who struggles with effective writing and reading skills will benefit from some interventions to enhance his spelling skills, which will eventually lead to increased academic success. Vangelova (2015) suggested that teachers should spend instructional time to address the challenge that pupils face in learning how to spell English words. Although this writer's point of view is important, in addition to providing appropriate instructional time for spelling, there is a need to identify research-based strategies that have been employed by successful spellers and then apply them to pupils with spelling difficulties.

According to Treiman (2018) and Parlindungan (2018) findings, it is necessary to deliberately teach spelling to pupils with spelling challenges rather than relying on incidental learning to teach them how to spell words. Pan, Rickard, and Bjork (2021) provide a thorough historical overview of spelling instruction. Based on their holistic analysis, the researchers concluded that teachers should use both conventional and current teaching strategies to help pupils with spelling problems. Bowers and Bowers (2017) proposed that pupils should be taught how to spell words by supporting them in comprehending the relationships between the English reading and writing systems, which include etymology, phonology, and morphology. This would allow pupils to understand the scientific basics of literacy as well as how the spelling system operates. This means that, like reading, spelling is a difficult skill that

every pupil should work on for improved academic success. In lieu of this, Morin (2020) has affirmed the efficacy of games in spelling training.

A study was conducted by Dymock and Nicholson (2017) involving fifty-five (55) primary three pupils who were taught spelling using two different strategies: rule-based and visual memory. Pupils learned vowel sound spelling strategies, syllable breaking tactics, and the doubling rule as part of the rule-based strategy. Pupils were asked to learn spelling using a look, say, cover; write, check, fix technique, in which words were listed in alphabetical order and put down in sentences as needed. Following the sessions, it was discovered that the participants' spelling skills improved. Participants in the rule-based strategy group, on the other hand, achieved more progress than those in the visual memory strategy and control groups because they engaged in more transfer to spelling of new words. This finding can be partly attributed to the point that beginner pupils are frequently taught guidelines governing vowels, consonants, and blends of vowels, and blends of consonants. Thus, it is easier for pupils to relate to those principles, and they learn reading, writing, and spelling more effectively when they apply those rules rather than when they are forced to execute visual memory activities.

In addition, Lazarus and Ogunsola (2016) used metacognition and direct instruction methodologies to teach spelling to sixty (60) pupils with spelling impairments. Following the training sessions, participants taught with direct instruction method made the greatest improvement in spelling performance, while participants taught with metacognition method obtained higher spelling improvement than participants in the control group who made the least improvement in spelling performance. This study agrees with that of some researchers, who found that learners with dyslexia and spelling problems performed better when they were given specific teaching that focused on phonics, orthography, and morphology (Galuschka, Gorgen, Kalmar, Haberstroh, Schmalz, & Schulte-Korne, 2020). However, Galuschka et al. (2020) could not find evidence to support the use of memorizing strategies to improve learning outcomes in spelling among pupils with dyslexia and spelling deficiencies. The goal of the present study was to see how a memory method called visual imagery and a purely cognitive strategy called cloze spelling strategy affected the spelling performance of pupils with learning impairments.

The impact of gender on performance in spelling among learners with disabilities in the area of learning and spelling who were exposed to the two therapies was also investigated in the present study. Mohamad (2018) used multidimensional and methodological methods to offer an overview of differences based on gender among pupils with learning disabilities from a neuropsychological perspective, arguing that there are disparities between the behaviour of male and female pupils who struggle with academic content. Previously, Moll, Kunze, Neuhoff, Bruder, and Schulte-Kome (2014) revealed that more boys than girls showed separate spelling deficiencies and combined reading difficulties, while more females struggled with mathematics. When looking into the impact of gender on the performance of pupils with learning impairments, it is important to note the suggestion of certain scholars that the male and female brains are biologically distinct, and that this difference has an impact on the majority of learning processes (Haddad, 2017).

A study conducted by Karimnia and Nouraey (2016) included 108 Iranian pupils aged eight to ten who were studying English as a second language (54 boys and 54 girls). The study discovered significant gender differences in spelling among the pupils, with the girls outnumbering the boys. Both groups of pupils scored significantly higher on words taught using the rhythmic approach to spelling rather than the nonrhythmic method, according to the findings. Nkomo and Uyanah (2020) examined the gender disparities in pupils exhibiting specific types of learning disabilities such as reading and mathematics disabilities, attention deficit hyperactivity disorder and dysgraphia. The findings showed that, only pupils with dysgraphia (spelling difficulties, poor organizational abilities, and a lack of coherence in writing) exhibited a substantial gender difference. Nkomo and Uyanah (2020) concluded that for better learning outcomes pupils should be encouraged to become more interested in writing tasks.

Furthermore, Lazarus and Ogunsola (2016) discovered that regardless of gender, the pupils' spelling performance remained consistent. As a result, the gender of pupils with spelling problems had no bearing on their spelling performance. Adams and Simmons (2019) found remarkable differences in alphabet transcription and writing quality across pupils aged 5 to 7 years old, regardless of their intellectual skills. On the other hand, the study did not find that gender was a major variable in prediction of spelling.

From the foregoing, the inability of pupils with learning disabilities to accurately spell words has been identified as one of the ascribed causes of school failure. It leads to poorly written compositions, distortion in thinking and poor handwriting. Poor spelling also results in socio-emotional difficulties. It should be noted that the remedies proposed in previous studies have not resulted in a reduction in the occurrence of poor spelling performance among pupils with learning and spelling disabilities especially, in Ibadan, Nigeria. Therefore, this study, determined the effect of visual imagery and cloze spelling instructional strategies, on the performance in spelling among pupils with disabilities in learning in Ibadan, Nigeria.

Hypotheses

At a significance level of .05, two null hypotheses were examined.

Ho1 There is no significant main effect of treatment on spelling performance of pupils with learning disabilities.

Ho2 There is no significant main effect of gender on spelling performance of pupils with learning disabilities.

Theoretical Framework

Two theories proposed by Ehri (2000); Frith (1985); Gentry (1982) namely, the Stage and Phase theories provided the framework. The two models submitted that children are required to gradually and sequentially pick up the various underlying linguistic elements. They move on to the following stage once they have attained a certain level of knowledge. The procedure is carried out in successive stages until they can learn these tasks. Pre-alphabetic phase, according to the submission of these theories, is a phase whereby pupils are yet to acquire the awareness of letter-sounds. Therefore, pupils rely on the visual characteristics and not on the sound values of words to recognise them. Thereafter, pupils make progress from this stage to a stage referred to as the partial alphabetic phase. During this stage, pupils decode by mapping some of the sounds in words to letters. At the third stage, known as the full alphabetic phase, decoding is done by mapping out all sounds in words to letters. Pupils at this stage are able to recognise words with automaticity. During the consolidated alphabetic phase, pupils demonstrate the ability to understand the operations of advanced skills relating to the awareness of phonemes such as deleting, substituting, and reversing of sounds.

The significance of these two theories as they relate to spelling development is well recognized (Treiman, 2017). These theories have inspired research demonstrating that spelling acquisition by pupils does not have to rely on rote learning, as proposed earlier (Jensen, 1962). Treiman (2017) reiterated that the stage and phase theories focus on the knowledge and use of phonological abilities in spelling. The rate of progression of mastering the developmental stages of learning to spell as described by the stage and phase theories differs among pupils who have diverse capabilities (Lerner & Kline, 2006). However, it should be noted that all pupils experience the stages of spelling acquisition sequentially. In addition, children's spelling mistakes reflect their current developmental stage (Lerner & Kline, 2006).

METHOD

Design

The pretest-posttest control group quasi-experimental design was adopted. Also, a representation of the study design is shown as follows (Table 1):

Table 1. The pre test-post test control group model.

Groups	Pre Test	Process	Post Test
Experimental group 1	0_1	X1	0_2
Experimental group 2	0_3	X2	0_4
Control group	0_5	-	0_6

Pretests for both experimental and control groups were 01, 03, and 05, and posttests for both experimental and control groups were 02, 04, and 06, respectively. Furthermore, X1 denotes the first experimental group. In addition, X2 denotes the second experimental group. Placebo treatment was given to those in the control group. The factorial matrix of 3x2 was used where "3" represents the two experimental and control groups and "2" represents gender (male and female).

Sampling Technique and Sample Size

The researchers employed a multi-stage sampling procedure. First, they chose three out of five Local Government Areas (LGAs) in the Ibadan Metropolis, Oyo State, Nigeria, using the ballot technique of random sampling. One public primary school in each of the three LGAs was chosen using a simple random sample procedure. Following that, a purposive sample of pupils was taken based on the presence of learning disabilities. To identify pupils with learning disabilities, the 1981 revised edition of the Pupil Rating Scale, designed by Myklebust (1971), was distributed to only 278 primary four learners in three selected schools who were nominated by their class instructors as low-achieving pupils (based on past academic records). Only 109 out of 278 low achievers identified from the selected schools were confirmed to be eligible for the study because of the presence of learning disabilities. Further screening was done by carefully checking the notebooks of pupils on English words dictated to them for a period of two academic terms. Each pupil's poor performance on the English words dictated to them was a sign that the pupil most likely had spelling difficulties. Disabilities in spelling are defined as a child's below average performance in spelling exercises of forty-nine percent (49%) or lower. Only 67 pupils out of a total of 109 pupils identified with learning disabilities were identified as having spelling problems. Sixty pupils were randomly chosen from those 67 pupils for the study. These 60 pupils were distributed into two experimental groups and the control group. Each of the three groups had twenty pupils, bringing the total number of participants to sixty. The average age of the participants was 9.35 years, with 68.3% of them being male (that is, 38 pupils). Only 36.6% (22 pupils), were female.

Instruments

For data gathering, the following instruments were used:

1. Pupil Rating Scale Revised
2. Pupils' Note Books on Dictated Words
3. Right Word Recognition

Description of Instruments

Pupil Rating Scale Revised (Myklebust, 1981)

This is a 24-item rating scale developed to assist teachers in identifying pupils in their courses who have learning impairments. Areas covered on the scale are comprehension of auditory information, oral language, orientation, co-ordination of motor skills and areas that relate to social and personal behaviour. On a five-point scale, teachers rate the twenty-four (24) behaviours (with "1" signifying poor conduct, "5" showing good conduct, and "3" suggesting average conduct). The maximum score that may be achieved is 120 (5 X 24). For example, if a child earns an average rating on all items, he or she will be awarded a "three" for each item, totaling 72. As a result, a score less than sixty (60) indicates the presence of learning disabilities in a pupil, and vice versa. Following a trial test, the scale's reliability coefficient was found to be .76 (Lazarus & Ogunsola, 2016) and this was adjudged as appropriate.

Pupils' Note Books on Dictated Words

These are the English note books of pupils on dictated words which were also screened to see whether any of the pupils have spelling problems. Pupils' scores on English words dictated to them in the past two academic terms were considered. Each pupil's poor performance on the English words dictated to them was a sign that the pupil most likely had spelling difficulties. Spelling disabilities are defined as a pupil's average performance in spelling exercises of forty-nine percent (49%) or lower.

Right Word Recognition

This is a spelling test created by the University of Jos' Department of Special Education. It includes a list of 100 high-frequency words as well as dates on which the child can demonstrate that he or she can read each one. The test was used to assess participants' spelling abilities both before (pretest) and after (posttest) the training sessions. To further establish the instrument's applicability, a trial-test was undertaken, yielding a reliability coefficient of .91 (Lazarus & Ogunsola, 2016).

Procedure for Data Collection

The researchers collected an introductory letter from the department and took it to the head teachers of the selected schools. The head teachers then handed the researchers over to the various class teachers in each of the schools. The researchers created rapport between themselves and the teachers by explaining the objectives of the research to them. This set the pace for the identification of pupils who manifest disabilities in learning and the screening of pupils with disabilities in spelling. The treatment lasted seven weeks, including two weeks for pre- and post-treatment evaluations. Research assistants (three of them) were trained and enlisted to carry out the experiment (one from each school). The participants were treated for five weeks, with the experimental groups receiving visual imagery and close spelling strategies respectively. Spelling instruction was delivered to those in the control group using the conventional approach. Because the pupils had learning impairments, they were taught five words from the Right Word Recognition twice a week.

Training in the visual imagery group involved asking the pupils to:

i. Look at word and say its name
ii. Close their eyes and imagine the word in their minds' eyes
iii. Name letters with their inside voices
iv. Open eyes and write word
v. Check spelling and repeat steps one through four if the word is not spelled correctly.

The cloze spelling group exposed participants to:

i. Look at the word on the card and think about it. Examine the word once more, paying attention to the letters and their placement.
ii. Write missing vowels from the same word on a card with blank(s) where the vowels usually appear.
iii. Write missing consonants from the same word on a card with blank(s) where the consonants usually appear.
iv. Write the word without the model.

The researchers also employed a variety of reinforcement tactics, such as clapping and handing out pencils and erasers as gifts. The researchers also took the time to mark the participants' positive responses. A posttest utilising Right Word Recognition was given in the seventh week of spelling training.

RESULTS

H_{01}: There is no significant main effect of treatment on spelling performance of pupils with spelling disabilities.

Table 2. Core effect of treatment on performance in spelling among pupils who demonstrate disabilities in learning.

Source	Sum of square	Df	Mean square	F	Sig.	Eta square
Corrected model (explained)	26028.022	3	8676.007	18.140	.000*	.493
Pretest	6001.222	1	6001.222	12.548	.001*	.183
Treatment group (main effect)	19212.130	2	9606.065	20.085	.000*	.418
Error (residual)	26783.378	56	478.275			
Corrected total	52811.400`	59				

*p<.05

Table 2 demonstrates that the pupils' spelling performance improved at the end of the training sessions held for pupils identified as having difficulties in the spelling skill area, employing visual imagery and cloze procedures as treatments $F_{(3,56)} = 2.085$. p<.05, $\eta^2 =$. 418). Hence, the null hypothesis is rejected. This implies that the treatments had a significant impact on the pupils' spelling abilities.

Table 3. Estimated marginal mean showing fundamental effect of treatment on spelling performance of pupils who have learning disabilities.

Treatment	Mean	Std. Error
Experimental Group I	80.47	4.891
Experimental Group II	76.97	4.896
Control	40.86	4.893

Table 3 reveals that the estimated marginal average scores of pupils in the three groups were 80.47, 76.97, and 40.86 for experimental group I, experimental group II, and control group, respectively. This indicates that the pupils in experimental group I outperformed those in experimental group II, while those in experimental group II outperformed those in the control group.

Table 4. Scheffe post-hoc analysis.

Group	Group	Sig.
Experimental Group I	Experimental Group II	.951
	Control	.000*
Experimental Group II	Experimental Group I	.951
	Control	.000*
Control	Experimental Group I	.000*
	Experimental Group II	.000*

*p<.05

The Scheffe Post-hoc analysis provided more information on the impact of instructional strategies on pupils' spelling proficiency. The analysis's synopsis is shown in Table 4.

H_{02}: There is no significant main effect of gender on spelling performance of pupils with learning disabilities.

Table 5. Effect of gender on the performance in spelling of pupils who have learning disabilities.

Source	Sum of square	Df	Mean square	F	Sig.	Eta square
Corrected model (Explained)	7379.801	3	3689.900	4.629	.014*	.140
Pretest	5691.133	1	5691.133	7.140	.010*	.111
Gender (Main effect)	563.908	1	563.908	.707	.404	.012
Error (Residual)	45431.599	57	797.046			
Corrected total	52811.400	59				

*p<.05

Table 5 demonstrates that the major influence of gender on the performance in spelling of pupils with disabilities in learning was not significant $F_{(2,57)} = 707$, p>.05, $\eta^2 = .012$). The researchers accept the null hypothesis. As a result, no noteworthy core effect of gender on the spelling performance of pupils who have disabilities in learning was found.

Table 6. Estimated marginal mean scores showing core effect of gender on spelling performance

Gender	Mean	Std. Error
Male	62.743	5.405
Female	69.038	5.048

The estimated marginal mean was also computed to further affirm that for pupils with learning disabilities, the major effect of gender on the performance in spelling was insignificant. Table 6 illustrates this result.

DISCUSSION, CONCLUSION and RECOMMENDATIONS

Effect of Treatments on Performance in Spelling among Pupils who have Learning Disabilities

The first hypothesis stated that, there is no important fundamental effect of treatments (visual imagery and cloze spelling methods) on the performance of pupils with learning impairments in spelling. The study's findings have demonstrated that the two strategies were beneficial in both experimental groups. Participants responded to both treatments in a positive way and made significant gains in their spelling performance, whereas those in the control group did not make significant gains. This suggests that visual imagery and cloze spelling strategies were significant in helping pupils with learning difficulties improve their spelling abilities. The findings showed that if pupils are taught how to spell words using the right method, they can progress and perform well. It was also discovered that pupils in the visual imagery group outperformed those in the cloze spelling group. This finding supports those reported by Treiman (2018) and Parlindungan (2018) that pupils with learning difficulties gain considerably from intentional spelling instruction rather than relying on accidental learning. The finding also supports Bower and Bower (2017)'s suggestion that learners should be taught spelling skills. Furthermore, the current study is consistent with Dymock and Nicholson (2017), who found that when rule-based and visual memory tactics were used in teaching spelling to pupils who struggled in school, positive effects were attained.

Effect of Gender on Pupils with Learning Disabilities' Spelling Performance

According to the second hypothesis, there is no important, fundamental effect of gender on how well students with learning difficulties spell. There was no substantial fundamental influence of gender on pupils with learning difficulties, according to the study in Table 5, leading to the null hypothesis being accepted. Gender is not a decisive factor for spelling proficiency in pupils with learning difficulties, according to the findings. The present finding contradicts those of Haddad (2017) that revealed the presence of gender differences among pupils who have disabilities in terms of academic skills. The present finding also contradicts the findings of Lazarus and Ogunsola (2016) and Adams and Simmons (2019), who found no significant gender differences in spelling abilities.

Conclusion

The present study found that pupils who have learning difficulties can improve their spelling expertise when trained with the visual imagery as well as close spelling instructional strategies. This is because these two strategies have been shown to be better than the standard listening and writing approach of teaching spelling. The present finding corroborate the underlying assumptions that visual imagery and close spelling procedures enable children to actively participate in the acquisition of knowledge with regard to spelling. This study finding also demonstrated that, rather than using traditional methods, instructors who take the time to develop themselves and imbibe good strategies in their teaching can effectively teach pupils with learning disabilities, resulting in desirable performances and good results from the students.

Limitations and Suggestions for Future Research

The generalizability of the findings of this study may be affected by the fact that only pupils with learning disabilities from government-owned or public primary schools were selected. It's possible that pupils from both public and private schools could be involved in future studies.

Recommendations

Following the study findings, certain recommendations are made as follows:

i) When teaching spelling to pupils who experience learning disabilities, primary school teachers should use the two instructional methodologies of visual imagery and cloze spelling.

ii) Primary school teachers are urged to improve their visual imagery and cloze spelling instruction skills through participation in workshops and other professional development programmes.

iii) To eliminate gender bias among teachers, parents and society in general, the government should raise public awareness through workshops, rallies, seminars, and conferences. This is because it was found in this study that when instructional methods are employed to remediate spelling difficulties in pupils with learning disabilities, gender had no influence on pupils' spelling performance.

iv) Teachers and parents should not dismiss any pupil with weak spelling skills; rather, such pupils should be given the opportunity to be educated using effective instructional methods such as visual imagery and close spelling.

v) Educators should keep in mind that visual imagery and close spelling strategies work for individuals, small groups, and large groups alike.

Ethics and Conflict of Interest

Ethical procedures in conducting the study were adhered to by the researchers and they declare that no conflict of interest exists.

REFERENCES

Adams, A. M., & Simmons, F. R. (2019). Exploring individual and gender differences in early writing performance. *Read Writ, 32*, 235–263. https://doi.org/10.1007/s11145-018-9859-0

Adoniou, M. (2014). What should teachers know about spelling?. *Literacy*, *48*(3), 144-154. https://doi.org/10.1111/lit.12017

Adoniou, M. (2016). *Spelling it out*. Cambridge: Cambridge University Press.

Barker, O., & Puente, M. (2013). Does spelling still matter? *USA Today, 6.*

Bowers, J. S., & Bowers, P. N. (2017). Beyond phonics: The case for teaching children the logic of the English spelling system. *Educational Psychologist, 52*(2), 124-141. https://doi.org/10.1080/00461520.2017.1288571

Dymock, S., & Nicholson, T. (2017). To what extent does children's spelling improve as a result of learning words with the look, say, cover, write, check, fix strategy compared with phonological spelling strategies? *Australian Journal of Learning Difficulties, 22*(2), 171-187. https://doi.org/10.1080/19404158.2017.1398766

Ehri, L. C. (2000). Learning to read and learning to spell: Two sides of a coin. *Topics in Language Disorders, 20*, 19-36. https://doi.org/10.1097/00011363-200020030-00005

Frith, U. (1985). *Beneath the surface of developmental dyslexia*. In K. Patterson, J. C. Marshall, & M. Coltheart (Eds.), Surface dyslexia: Neuropsychological and cognitive studies of phonological reading (pp. 301–330). London, England: Erlbaum.

Galuschka, K., Grogen, R., Kalmar, J., Haberstroh, S., Schmalz, X., & Schulte-Korne, G. (2020). Effectiveness of spelling interventions for learners with dyslexia: A meta-analysis and systematic review, *Educational Psychologist, 55*(1), 1-20. https://doi.org/10.1080/00461520.2019.1659794

Gentry, J. R. (1982). An analysis of developmental spelling in "GNYS AT WRK". The Reading Teacher, 36, 192–200.

Gentry, J. R. (2010). No spelling book in your child's book bag spells trouble ahead!. *Psychology Today*.

Haddad D (2017). Gender differences in learning disabilities. *Learning disabilities Basics.* USA: HONcode standard for trustworthy health.

Hamdi, S. (2016). An analysis of lexical errors in the English compositions of EFL Tunisian learners. *International Journal of Humanities and Cultural Studies (IJHCS), 2*(4), 643-652.

Jensen, A. R. (1962). Spelling errors and the serial-position effect. *Journal of Educational Psychology*, *53*, 105-109. https://doi.org/10.1037/h0042141

Lazarus, K. U. (2016). Academic achievement deficits of adolescents with learning disabilities: Implications for regular and special needs education teachers in Nigerian Secondary Schools. *African Journal of Educational Management*, *17*(2), 135-148.

Lazarus, K. U., & Ogunsola, G. O. (2016). Effects of metacognition and direct instruction on spelling abilities of pupils with learning disabilities in primary schools in Ibadan, Oyo State, Nigeria. *European Scientific Journal (ESJ)*, *12*, 227-227.

Lerner, J. W. & Kline, F. (2006). *Learning disabilities and related disorders: Characteristics and teaching strategies, 10th edition.* Boston, New York: Houghton Mifflin Company.

Martin-Lacroux, C. (2017). "Without the spelling errors I would have shortlisted her…": The impact of spelling errors on recruiters' choice during the personnel selection process. *International Journal of Selection and Assessment, 25*(3), 276–283. https://doi.org/10.1111/ijsa.12179

Mohamad, Q. A. (2018). Gender difference in learning disabled children Neuropsychological review. *Research and Reviews on Healthcare: Open Access Journal, 1*(3), 44-48. https://doi.org/10.32474/RRHOAJ.2018.01.000111

Moll, K., Kunze, S., Neuhoff, N., Bruder, J., & Schulte-Körne, G. (2014). Specific learning disorder: Prevalence and gender differences. *PLoS one, 9*(7), e103537.

Morin, A. (2020). Creative ways to help your youngster practice spelling words. ThoughtCo.

Myklebust, H. R. (1981). *Pupil rating scale revised: Screening for learning disabilities.* New York: Grune and Stratton, Inc.

Pan, S. C., Rickard, T. C., & Bjork, R. A. (2021). Doesspelling still matter-and if so, how should it be taught? Perspectives from contemporary and historical research. *Educational Psychology Review*, *33*, 1523-1552. https://doi.org/10.1007/s10648-021-09611-y

Parlindungan, F. (2018). *What research has to say about spelling instruction for English language learners*. Proceedings | International Seminar on English Language Teaching and Research (ELTAR), (2018, p. 310-325).

Treiman, R., & Kessler, B. (2014). *How children learn to write words*. Oxford University Press.

Treiman, R. (2017). Learning to spell words: Findings, theories, and issues. *Scientific Studies of Reading*, *21*(4), 265-276.

Treiman, R. (2018). Teaching and learning spelling. *Child Development Perspectives*, *12*(4), 235-239. https://doi.org/10.1111/cdep.12292

Vangelova, L. (2015). How spelling keeps kids from learning. The Atlantic.

Van Staden, A. (2010). Improving the spelling ability of grade 3 learners through visual imaging teaching strategies. *Per Linguam: A Journal of Language Learning= Per Linguam: Tydskrif Vir Taalaanleer*, *26*(1), 13-28.

IOJPE

ISSN: 1300 – 915X
www.iojpe.org

International Online Journal of Primary Education *2023, volume 12, issue 1*

PEDAGOGICAL CLASSIFICATION OF EDUCATIONAL ROBOTS IN PRE-SCHOOL TEACHING

Muhammed Murat GÜMÜŞ
Lecturer, Amasya University, Institute of Science, Amasya, Türkiye
ORCID: https://orcid.org/0000-0002-3677-8928
muhammed.gumus@amasya.edu.tr

Osman KAYHAN
Lecturer, Amasya University, Institute of Science, Amasya, Türkiye
ORCID: https://orcid.org/0000-0001-5407-6375
osman.kayhan@amasya.edu.tr

Özgen KORKMAZ
Ph.D., Professor, Amasya University, Department of Computer Engineering, Amasya, Türkiye
ORCID: https://orcid.org/0000-0003-4359-5692
ozgenkorkmaz@gmail.com

Halis ALTUN
Ph.D., Professor, Istanbul Health and Technology University,
Department of Software Engineering, İstanbul, Türkiye
ORCID: https://orcid.org/0000-0002-2126-8757
halis.altun@istun.edu.tr

Nihat YILMAZ
Ph.D., Selçuk University, HANARGE Industrial Electronics Information Systems Ltd. Konya, Türkiye
ORCID: https://orcid.org/0000-0003-1340-9270
nihatyilmaz@hanarge.com

Received: September 19, 2022 **Accepted:** January 22, 2023 **Published:** March 31, 2023

Suggested Citation:
Gümüş, M. M., Kayhan, O., Korkmaz, Ö., Altun, H., & Yılmaz, N. (2023). Pedagogical classification of educational robots in pre-school teaching. *International Online Journal of Primary Education (IOJPE), 12*(1), 25-41. https://doi.org/10.55020/iojpe.1177237

Abstract

This study aims to create a rubric based on the pedagogical properties of educational robots for pre-school students and determine the compliance level with educational robot sets. In this sense, the study is considered a first and significant step toward selecting robots based on pedagogical-driven factors. For this aim, a mixed-method research design was employed. A qualitative method was used to create the rubric items, and the rubric development was also supported through a quantitative process by including expert opinions and ensuring content validity. Furthermore, a descriptive survey model, one of the quantitative designs, was used to examine the suitability of educational robots for the pre-school education level. As an outcome of this study, a rubric of four dimensions with 28 items related to the pedagogical features of educational robots in pre-school was created. Furthermore, widely used educational robots at the pre-school level, such as Kidoboto, Lego Wedo, Mbot, Lego Spike, Lego Ev3, and Matatalab, were evaluated by experts using the created rubric.

Keywords: Educational robots, 21st-century skills, rubric, pre-school student.

INTRODUCTION

We live in an age where we expect students to acquire 21st-century skills and develop higher-order thinking skills. At this age, students are expected to have skills such as being adapted to changes in society, using technology effectively and correctly, finding the information required quickly from complex information stacks, and evaluating data obtained effectively by analyzing and using the information in their daily lives (Tuğluk & Özkan, 2019). In the literature, various definitions and

classifications are available for the 21st-century required skills (Assessment and Teaching of 21st-century Skills Framework [ATC21S], 2010; International Society for Technology in Education National Education Technology Standards [ISTE], 2019; Ministry of National Education [MONE], 2013; Partnership for 21st-century Learning [P21], 2019). Among these, the classification made by the Partnership for 21st-century learning (2019) is generally accepted. It is observable that most of the studies conducted recently are based on this classification (Kalemkuş & Bulut Özek, 2021; Yıldırım & Ortak, 2021; Dinler et al., 2021). 21st-century skills are grouped under three main headings by P21 (2019): learning and innovation, information media and technology, and life career skills. (P21, 2019). The P21 platform categorizes 21st-century skills, as shown in Table 1.

Table 1. 21st-century skills of the P21 platform

Learning and Innovation Skills	Life and Career Skills	Information, Media, and Technology Skills
Creativity and Innovation	Flexibility and Adaptability	Information and Media Literacy
Critical Thinking and Problem-Solving	Initiative and Self-Direction	
Communication	Social and Cross-Cultural Skills	
Collaboration	Productivity and Accountability	
	Leadership and Responsibility	

Learning and innovation skills, life and career skills, information, media and technology skills are the ones that every individual should acquire to get prepared well for the even-getting more complex daily life and work environments of the 21st century (Yıldırım & Ortak, 2021). For individuals to use 21st-century skills effectively, acquiring these skills should start as early as pre-school (Çetin & Çetin, 2021). In early childhood, children develop skills such as logical thinking, estimation, hypotheses, and analysis (Katz, 2010). Therefore, the activities to foster students in acquiring these skills in early childhood would help develop their potential and increase their readiness for upcoming educational stages. (Polat & Bardak, 2019). In line with this trend, the Ministry of National Education (2013) emphasized the importance of bringing 21st-century skills to children in the pre-school education program and prepared most of the acquisitions by considering these skills. Different kinds of approaches are in use for students to acquire these skills. Some of them are based on using educational robots and coding education (Khodabandelou & Alhoqani, 2022; Yang et al., 2022; Usengül & Bahçeci, 2020; Sáez-López et al., 2019; Korkmaz, 2018).

Educational robots have been used as a part of educational studies through various activities. For example, educational robots have been used in activities aimed at increasing the academic achievements and the attitudes of students, such as programming, problem-solving, computational thinking, STEM, and logical-mathematical thinking skills (Kaya et al., 2020; Korkmaz et al., 2019; Memiş, 2020; Paucar-Curasma et al., 2022; Yang et al., 2022; Marzano & Zorzi, 2022). Some features of the educational robots, such as Lego Wedo, Lego Spike, Lego EV3, Lego Boost, Mbot, and Matatalab, which are used in these studies, are given in Table 2.

Examining Table 2 reveals that there are various kinds of educational robots to use, which show similar and different structures. Using these robots, it is aimed to gain other skills for multiple activities. In the literature, McAllister and Glidden (2022) used Lego Spike sets to teach robotic concepts and evaluated the teaching of robotics concepts with students' teachers. In another study, Tweedale (2022) proposed using Lego EV3 sets in teaching robotic concepts. Khodabandelou and Alhoqani (2022) have conducted studies using Lego Wedo educational robots for primary school students to acquire computational thinking skills and adopt robot technology. In yet another study, Usengül and Bahçeci (2020) investigated the effect of the Lego Wedo 2.0 educational robot on students' academic achievement, attitudes, and computational thinking skills. However, Veselovská and Mayerová (2017) developed various activities with the Lego Wedo robot to develop a secondary school curriculum to improve

students' knowledge, skills, and abilities. Yang et al. (2022) investigated the implications of Matatalab, another educational robot, on the education of primary and pre-school students.

Table 2. Features of educational robots

Educational Robots							
Features	**Lego EV3**	**Lego Spike**	**Lego Wedo**	**Lego Boost**	**Matatalab**	**MBot**	**Kidoboto**
Robot Type	Demounted	Demounted	Demounted	Demounted	mounted	mounted	mounted
Coding Type	Codable with various methods	Codable with various methods	Codable with various methods	Codable with various methods	Coding with blocks	Codable with various methods	
Interface	Interface available	Interface available	Interface available	Interface available	No interface available	Interface available	No interface available
Number of pieces	The number of pieces was 541	The number of pieces was 528	The number of pieces is 280	The number of pieces was 847	Single Piece	Single Piece	Single Piece
Package content	Motor and sensors	Motor and sensors	Motor and sensors	Application Booklets and sensors	Control cards, blocks, obstacles, flags, maps, and booklets	Remote control and mission maps	Application booklets and mission map

Moreover, Korkmaz (2018) observed the effect of programming with the Lego EV3 robot on students' problem-solving and logical-mathematical thinking skills. Veselovská, Mayerová (2017) have developed various activities with the Lego Wedo robot to improve students' knowledge, skills, and abilities in their work on developing the secondary school curriculum. Yang et al. (2022) investigated the implications of educating primary and pre-school students with Matatalab. In another study, Korkmaz (2018) observed the effect of programming with the Lego EV3 robot on students' problem-solving and logical-mathematical thinking skills. However, Sáez-López et al. (2019) investigated the impact of using the Mbot robot on the mathematical thinking skills of primary school students. Turkish engineers developed the Kido-Boto robot as a Montesorri and STEM material for school students. Before the Kidoboto robot was included in the study, it was examined by field experts and researchers who thought it could be included. In line with the opinions of experts and researchers, it has been predicted that the kidoboto robot can easily teach coding to pre-school students.

Additionally, it was stated that with this robot, students could code with a concrete programming approach and stories and games prepared for this without being connected to the screen. In this context, it was thought that the Kidoboto robot could help students improve their communication and physical development, social and emotional skills, and counting and problem-solving skills. It also helps achieve gains in communication skills, physical development, social and emotional skills, counting skills, and problem-solving and logical reasoning. All these studies focused on similar skills and acquisitions with educational robots that provide various activities. Educational robots have been observed to be effective in developing students' programming, problem-solving, computational thinking, STEM, and logical-mathematical thinking skills and in increasing students' academic achievement and attitudes (Khodabandelou & Alhoqani, 2022; Usengül & Bahçeci, 2020; Korkmaz, 2018; Sáez-López et al., 2019) and educational robot designs have been developed to contribute to this line of trends. Therefore, it is possible to claim that educational robots are central to pedagogy.

It is thought that pedagogical features for educational robots are central to determine the effectiveness of approaches, ensure the progress of the learning process working correctly, and make the incorporation of the educational robot in the educational process meaningful (Tang, Tung, & Cheng, 2020). However, it has been observed that the studies on educational robots do not focus properly on pedagogical approaches and theoretical frameworks and that the studies lack pedagogical practices, and it is often

emphasized that pedagogical approaches and theoretical perspectives are to be incorporated in educational robot studies (Xia & Zhong, 2018; Serholt, 2018; Schina, Esteve-González & Usart, 2021; Atman Uslu, Öztüre Yavuz & Koçak Usluel, 2022). Therefore, it can be said that studies aimed at determining the pedagogical characteristics of educational robots will fill a gap in the literature. For this reason, it is thought essential to examine the classifications of educational robots in the market to match educational robots to students' achievements in educational processes and to determine their pedagogy of educational robots. Some studies highlight these requirements for classifying educational robots (O'Brien, 2020; Pei & Nie, 2018; Kocaçil, 2020).

O'Brien (2020) classified educational robots by considering the physical design, coding, and training method in his study. His classification is shown in Figure 1.

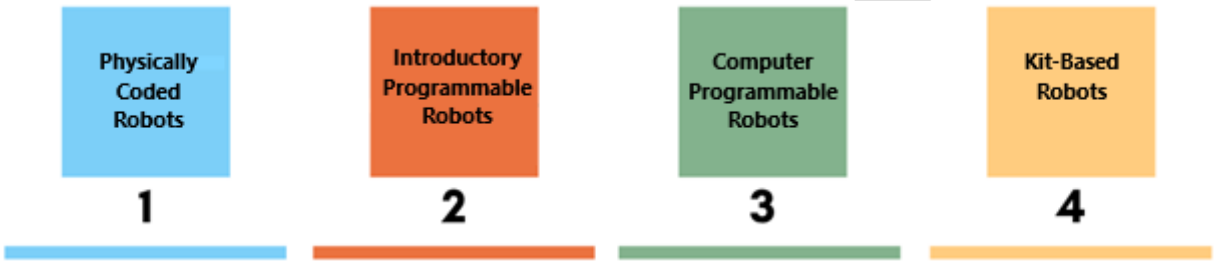


Figure 1. O'Brien's educational robot classification

As shown in Figure 1, O'Brien (2020) divided educational robots into four groups: physically coded robots, basic-level programmable robots, computer-programmable robots, and KIT-based robots. Physically coded robots are mounted robots. They are programmable with buttons and are primarily prepared for pre-school students. A learning process can be provided using game-based activities with these robots. Therefore, structured tasks and activities can be designed. Examples of robots that can also teach basic skills are the Kidoboto, Bee-Bot Robot, Cubetto Robot, Code-a Pillar Robot, and Thymio Robot. Robots programmed at the entry level are mounted robots that can be coded with a tablet, smartphone, and remote control and are intended for primary school students. A learning path can be provided with these robots by using game-based activities. Therefore, structured tasks and activities can be designed with these robots. Bootley Robot can be given as an example of a robot that can be used to teach basic writing and coding. Robots that can be programmed with a computer are assembled robots. It allows for block-based or text-based coding and is intended for elementary and secondary school students. These robots, structured tasks, and activities can be designed. This can provide a programmatic learning path using different sensors. It also allows complex and creative coding. Examples of these robots are Edison Robot, Sphero Bolt, and Mbot. Kit-based robots, unlike other robots, are unmounted. Students are expected to mount and program the robots by themselves. It allows block-based or text-based coding. Structured tasks and activities can be designed with robots for high school students. Robots that enable programming-based learning by using the electronics and engineering knowledge of the users also help complex and creative coding by using problem-solving skills. Examples of these robots are LEGO Mindstorms EV3 and VEX.

In a study, Pei and Nie (2018) classified educational robots by considering the functions of the robots and user knowledge. His type is shown in Figure 2.

Figure 2. Pei and Nie's educational robot classification

As shown in Figure 2, Pei and Nie (2018) divided educational robots into four groups: intelligent assistant robots, virtual simulation robots, non-common educational robots, and multi-functional suite robots. Intelligent assistant robots are speech systems that can use natural language technology. Thus, it is integrated with artificial intelligence. It also performs semantic recognition, emotional awareness, data mining, and analysis. An example of these robots is the Jill robot developed by IBM. Virtual simulation robots perform simulation and interaction tasks running on computers. Therefore, 3D graphics and simulation are in use. These robots have been used to develop students' practical and innovative abilities and used in experimental studies or competitions. Microsoft Robotics Studio and iRobotQ 3D are examples of these robots, to name a few. Uncommon educational robots, however, are intended for special groups such as special needs education students. These robots can imitate facial and muscle movements or body behavior. It can also improve the emotional and social abilities of students with autism. Smart toys for preschoolers, medical education robots for medical students, and language training robots for language learning are examples of these educational robots. Finally, multi-functional suite robots develop students' knowledge and skills. They can be freely assembled according to the teaching requirement, and they are suitable to be used by pre-school pupils to seniors. Different modules can be combined to complete various tasks and are ideal for STEM activities. Examples of these robots are the LEGO Kits and Ability-Storm.

However, Kocaçil (2020) stated in his study that Parallax Robotics Sets, Fischertechnik Sets, Lego Mindstorms Sets, Makeblock Sets, VEX IQ Platform Sets, and Robotic Sets could be used as educational robots. To this end, he classified the educational robots according to their grade levels. He divided them into three groups a pre-school-primary school group, a middle school group, and a high school group. Educational robots classified in the preschool-primary school group are Cubetto, Cody Rocky, Bee-Bot, Clementoni, and LEGO Wedo 2.0; in the middle school groups are Makeblock Mbot, Makeblock mbot ranger, Makeblock ultimate, Robotis Dream, and LEGO Mindstorms EV3, and in the high school groups are LEGO Mindstorms EV3, VEX IQ, and Arduino UNO kits.

However, Bravo, González, and González (2017) divided the programming languages used in educational robots into five groups as such as general programming languages, particular programming languages, visual programming languages, concrete programming languages, and text and visual programming languages. C/C++, Java, and Phyton languages are examples of available programming languages. Examples of specific programming languages are ROBOTC (LEGO Mindstorms and VEX Robotics), Aseba Studio (Thymio ROBOT), Robot Mesh Studio (VEX), and LeJOS (LEGO Mindstorms). In addition, however, Scratch, MBlock, Lego Mindstorms EV3, NXT-G, Built-in Studio for WeDo 2.0, PicoBlocks, Aseba Studio, Microsoft VPL, MySkit, Choregaphe are listed as examples of visual programming languages.

However, the tangible programming languages Cubetto, Kibo, Project Bloks, CHERP, Tern, Playte, PROTEAS, Algoblocks, and Robo-Bloklar are given as examples. Finally, Blockly, Tickle, The Coder MIP App, R+ Task 2.0, EasyC, Scratch, Enchanting, Ardublock, MiniBloq, Modkit, and Alice are shown as examples of text-based and visual programming languages. In another study, Fessakis, Gouli, and Mavroudi (2013) stated why the educational robots classified in their research should be chosen for children. They indicated that software environments such as Scratch, Stagecast Creator, Squeak Etoys, Microworlds, and Toon Talk are helpful and straightforward for primary school students. The features of these programs that they think are suitable for children are listed as follows: having simple symbols and syntax, using drag-and-drop methods, having remarkable visual designs and characters, instantly viewing whether the codes are working, being away from traditional education, and providing game-based learning. However, when the relevant research is examined, it is seen that the classification of educational robots is not evaluated primarily in terms of pedagogical features. Additionally, although it is seen that the characteristics and types of educational robots have been made generally, it is often emphasized that there is no focus on their pedagogical features. There is a lack of explanations of pedagogical features.

In this context, this study attempts to determine the pedagogical characteristics of educational robots by examining studies on 21st-century skills and educational robots, with special focus to create a rubric that includes these features. The second part of the study aims to investigate the suitability of the educational robot sets, which are frequently used, for the pre-school education level by using the rubric obtained.

In this sense, this study focuses on the pedagogical features of educational robots, unlike previous studies on educational robots. Therefore, it is thought that it will contribute to the literature on the pedagogical evaluation of educational robots based on 21st-century skills. Additionally, it is believed that it will guide teachers in using educational robots suitable for the level of pre-school students. However, it is thought that the rubric developed for future research will contribute to future research in determining whether the newly designed educational robots are suitable for the level of pre-school students and choosing the prominent features of different educational robots.

Research Problem

1. What are the pedagogical features of educational robots that are widely used in the literature?

2. Is the rubric tool developed to evaluate the pedagogical characteristics of educational robots valid and reliable?

METHOD

This study was conducted in two stages. In the first stage, the rubric was developed, and in the second stage, the suitability of the developed rubric and educational robots for the pre-school education level was evaluated. A mixed-method research design was employed in this study. A qualitative method was used to create the rubric items, and the rubric development was also supported through a quantitative process by including expert opinions and ensuring content validity. Furthermore, a descriptive survey model, one of the quantitative designs, was used to examine the suitability of educational robots for the pre-school education level.

Study Group

In this study, the study group consists of five academicians, two of whom work in the field of Educational Sciences, one in the area of Computer Technologies, one in the field of Computer and Instructional Technologies Education, and one in the field of Software Engineering. They are experts in developing rubric tools and have previous experience with educational robots. Furthermore, four experts, two Computer and Instructional Technologies Education teachers, and two field experts, who are experienced in robotics, are involved in the evaluation of educational robots. However, a total of seven educational robots, namely, Kidoboto, Lego EV3, Mbot, Lego Spike, Lego Wedo, Matatalab, and Lego Boost, were included in the evaluation.

Development of Data Collection Tool

The literature has been reviewed to create rubric items, and the classification of educational robots and the achievements of pre-school students' 21st-century skills have been examined. The findings show that different definitions and categories are available at the national and international levels (ATC21S, 2010; ISTE, 2019; MONE, 2013; P21, 2019). From these studies, the P21 platform has gathered 21st-century skills under the headings of learning and innovation skills, life and career skills, information, media, and technology skills. Using these definitions and classifications, 21st-century skills were discussed on different topics, and achievements have been determined (Kalemkuş & Bulut Özek, 2021; Yıldırım & Ortak, 2021; Dinler et al., 2021) A 24-item rubric is created considering the findings of the literature review. The designed rubric items are e-mailed as forms to five experts in the field to determine the structural suitability and intelligibility level. Opinions have been made about the rubric items created by these experts. Experts have been asked to evaluate rubric items using options such as "appropriate, inappropriate, and correctable" to assess them. To identify the items that are not suitable and need to be corrected, the section "Your warning/suggestion regarding the item" was created, and they were asked to explain in the section. Additionally, apart from the listed items in the form, the "Item Suggestions"

section was created for the items the experts believe should be added. Table 3 contains some information about expert opinions.

Table 3. Examples of expert opinions on rubric substances

Expert	Rubric Item	Evaluation	Explanation
Expert 1	It should allow for different activities/tasks.	Improvable.	What kind of these different activities?
Expert 2	It should allow for different activities/tasks.	Improvable.	This feature requires the robot's complex design, which may not be particularly suitable for preschoolers. But it is necessary for high-level users.
Expert 3	Error codes/messages are displayed on the interface.	Improvable.	On the interface or the screen? The phrase "on screen" seemed to be too much.
Expert 4	The interface features remarkable visual design and characteristics.	Improvable.	What if the visual designs are eye-catching but lack character?
Expert 5	The settings of the robot can be adjusted in different ways.	Improvable.	This was a bit of an ambiguous statement. Perhaps it will be clearer as follows: "It can adjust the robot's settings according to its purpose."

After obtaining the experts' opinions, the rubric items have been re-examined, and the necessary arrangements have been made. The items that need to be removed from the rubric items have been removed, items deemed appropriate to be added have been added, and items that need to be edited have been updated in line with expert opinion. As a result, a pedagogical rubric is obtained for educational robots with 32 items consisting of 0–4 points.

During the creation of the rubric, to evaluate the harmony of the experts, they were asked to assess the final version of the rubric in the range of "1-Appropriate, 2-Adjustable, 3-Not Appropriate." Although according to the compliance assessment of the experts, adjustments were made in items 1 and 6, item 30 was removed from the rubric. Therefore, 31 items were evaluated. According to Miles and Huberman (1994), the percentage of consensus is calculated as follows.

Percentage of Consensus = Consensus / (Consensus + Disagreement) x 100

In this study, the calculation of the consensus percentages was made by the researcher for each question separately. Accordingly, for items 1, 2, 6, 7.9, 10, 11, 12, 17, 18, 20, 24, 27, and 29, the consensus percentage is 80.00%, and the consensus percentage in the other items is calculated as 100.00%. The consensus percentage for all items was found to be 91.33%. If the consensus rate between experts is higher than 70%, it can be said that their coding is reliable (Creswell, 2017).

It has been determined that the rubric items created with expert opinions are acceptable to evaluate educational robots fairly. Additionally, rubric items were divided into factors according to expert opinions, twenty-first-century features, and features of educational robots. An expert view was sought for the factors' terminology, which was taken from the statements in the items. In this direction, four elements have been created. Accordingly, items 3, 12, 23, 27, 28, 60, and 31 are named "Flexibility and Adaptation" (total number of items n=7), items 1, 5, 11, and 26 are designated as "Technological Integration" (total number of items n=4), articles 4, 8, 9, 10, 13, 14, 15, 16, 17, 18, 20, 24, 25, and 29 are named as "Support to Learning" (total number of items n=14) and articles 6, 7, 19, 21, 22, and 2 are called "Educational Design" (total number of items n=6). The rubric given in the final form is presented in Annex 1.

Data Analysis

With the developed rubric, the educational robots, Kidoboto, Lego EV3, Mbot, Lego Spike, Lego Wedo, Matatalab, and Lego Boost, were evaluated between 0 and 3 points by four experts. The data obtained from the four experts have been averaged separately for each robot. However, each factor was averaged and examined on a factor basis. In this direction, educational robots were compared according to the averages obtained. Additionally, the consensus percentage (Consensus / (Consensus + Disagreement) x

100) was calculated for the rate of consensus of expert opinions when developing the rubric and for calculating the percentage of harmony of the responses given by the experts in the evaluation of the rubric and robots. Accordingly, the rates of consensus of the answers provided by the experts in the assessment of the robots with the rubric are given in Table 4.

Table 4. Percentage of consensus according to expert evaluations of educational robots

Item No	Educational Robots						
	Kidoboto	Lego EV3	MBot	Lego Spike	Lego Wedo	Matatalab	Lego Boost
	Consensus Percentage						
1	75	100	40	50	75	100	50
2	100	75	50	75	75	100	75
3	75	100	100	100	100	75	75
4	75	75	75	100	100	75	75
5	100	100	50	75	100	75	75
6	75	50	50	50	75	75	75
7	75	40	40	40	75	40	75
8	75	50	40	50	100	75	75
9	100	50	100	100	75	40	100
10	100	50	75	75	100	40	50
11	100	75	75	75	40	40	40
12	100	40	40	40	75	75	50
13	75	75	75	50	100	75	50
14	75	50	75	50	75	50	75
15	40	75	50	75	100	75	50
16	40	100	50	75	50	50	75
17	75	40	75	40	0	75	75
18	100	100	75	75	50	40	75
19	75	75	40	75	75	40	75
20	100	75	100	75	75	75	100
21	100	50	75	50	50	40	75
22	75	100	100	40	40	40	50
23	40	50	40	50	75	50	75
24	75	75	100	75	75	50	75
25	40	75	75	40	40	40	75
26	100	75	50	100	100	100	75
27	75	50	75	75	75	75	75
28	40	75	50	50	75	75	75
29	100	75	75	75	100	40	75
30	75	100	50	50	100	40	40
31	50	50	50	40	100	40	75

When the consensus percentages for the Kidoboto educational robot are analyzed in Table 4, there is 100% consensus for items 2,5,9,10,11,12,18,20,21,26, and 29; while for items 1,3,4, 6,7,8,13,14,17,19,22,24,27, and 30, it is 75%; and for item 31, it is 50%, and for items 15,16,23,25 and 28 it is 40%. When the consensus percentages for the Lego EV3 educational robot are examined, there is 100% agreement for items 1,3,5,16,18,22, and 30; while for items 2,4,11,1315,19,20,24,25,26, 28, and 29, it is 75%; and for items 6,8,9,10,14,21,23,27 and 31 it is 50%; there is 40% consensus for items 7, 12, and 17. When the consensus percentages for the Mbot educational robot are examined, it is 100% for items 3,9,20,22, and 24; for items 4,10,11,13,14,17,18, 21,25,27, and 29, it is 75%; and it is 50% for items 2,5,6,15,16,28,30 and 31; there is 40% consensus for items 1,7,8,12,19 and 23. When the consensus percentages for the Lego Spike educational robot are examined, there is 100% consensus in items 3,4,9 and 26, while for items 2,5,10,11,15,16,18,19,20,24,27, and 29, it is 75%; it is 50% for items 1,6,8,13,14,21,23,28, and 30; there is 40% consensus for items 7,12,17,22,25 and 31. When the consensus percentages for the Lego Wedo educational robot are examined, there is 100% agreement in items 3,4,5,8,10,13,15,26,29,30, and 31; while for items 1,2,6,7,9,12,14,19,20,23,24,27, and 28, it is 75%; it is 50% for items 16, 18, and 21; it is 40% consensus for items 11.22 and 25 and 0% for item 17. When the consensus percentages for the Matatalab educational robot are examined, there is 100%

consensus in items 1,2 and 26, while it is 75% for items 3,4,5,6,8,12,13,1517,20,27, and 28; it is 50% for items 14, 16, 23, and 24; there is 40% consensus for items 7,9,10,11,18,19,21,22,25,29,30, and 31. Finally, when the consensus percentages for the Lego Boost educational robot are examined, there is 100% consensus in items 9 and 21, while for items 2,3,4,5,6,7,8,14,16,17,18,19,21, 23,24,25,26,27,28,29, and 31, it is 75%; for the items 1,10,12,13,15, and 22 it is 50%, and it is 40% for items 11 and 30.

According to the evaluations by the experts, if the consensus rate is higher than %70, it can be said that coding is reliable (Creswell, 2017; Miles & Huberman, 1994). However, when the consensus percentages of the experts are examined separately for each educational robot, it is seen that items show a low consensus rate below 70%. It is thought that this is because the experts evaluating the items have different backgrounds in educational robots. Therefore, the experts' observation of educational robots is based on other activities and examples while assessing.

FINDINGS

The average scores for the educational robots, in line with expert opinions, according to the Technological Instructional Design factor and related items, are shown in Table 5.

Table 5. Average scores of educational robots by technological integration factor

I	Item	Kidoboto	Lego EV3	MBot	Lego Spike	Lego Wedo	Matatalab	Lego Boost
1	Settings that affect the characteristic behavior of the robot can be adjusted.	0	3	1.7	2.5	2.7	0	2
11	It is possible to use other technologies (smartphones, 3D printers, etc.) to conduct various activities.	0	2.2	2.5	2.2	1.7	1	2
26	It is controllable by various technologies (Tablet, computer, remote control, etc.).	0	2.7	2.5	3	3	0	2
5	The drag-and-drop method was used at the interface.	0	3	2.5	2.7	3	.7	3
Technological Integration		0	2.8	2.3	2.6	2.6	.4	2.3

When Table 5 is examined, according to the item (M=1: "settings that affect the characteristic behavior of the robot can be adjusted."), the educational robot with the highest score was Lego Spike, and the educational robot with the lowest score was Kidoboto and Matatalab. According to the item (M=11: "It is possible to use other technologies (smartphones, 3D printers, etc.) to conduct various activities."), the educational robot with the highest score is Mbot, and the educational robot with the lowest score is Kidoboto. According to the item (M=26: "It is controllable by various technologies (Tablet, computer, remote control, etc.)."), the educational robot with the highest score was Lego EV3, and the educational robot with the lowest score was Kidoboto and Matatalab. According to the item (M=5: "The drag-and-drop method is used in the interface."), the educational robot with the highest score was Lego Spike, and the educational robot with the lowest score was Kidoboto. Finally, according to the technology integration factor average scores, it can be said that the robot with the highest score was Lego Ev3, and the educational robot with the lowest score was the Kidoboto robot. Additionally, when educational robots are evaluated according to the Technological Integration factor, the use of Lego EV3, Lego Wedo, Lego Spike, Lego Boost, and Mbot robots seems to be more suitable in pre-school education regarding the scores obtained for the items as shown in Table 5. The average scores of educational robots, in line with expert opinions, according to the Instructional Design factor and related items, are shown in Table 6.

Table 6. Average scores of educational robots by educational design factors

I	Item	Kidoboto	Lego EV3	MBot	Lego Spike	Lego Wedo	Matatalab	Lego Boost
2	Error codes or messages are displayed at the interface.	0	.2	1.5	.2	.2	0	0
6	The interface contains appropriate visual designs.	.2	2.5	2.5	2.5	2.7	.5	3
7	There are remarkable visual characters at the interface.	.2	1.7	2.2	2	2.7	1,2	3
19	It checks whether the codes work properly for the purpose or not.	.2	.2	1,7	.2	.2	.7	0
21	The visual design of the robot is interesting.	1	2.5	2.2	2.5	2.5	2	2
22	The visual design of the interface is interesting.	.2	2	2	2,2	2	1.2	2
Educational Design		Educational Design	1.5	2.0	1.6	1.8	1.0	1.7

An examination of Table 6 reveals that according to the item (M=2), the educational robot with the highest score is Mbot and the educational robot with the lowest score is Kidoboto and Matatalab. According to the item (M = 6), the educational robot with the highest score is Lego Wedo, and the educational robot with the lowest score is Kidoboto. According to the item (M = 7), the educational robot with the highest score was Lego Wedo, and the educational robot with the lowest score was Kidoboto. According to the item (M=19), the educational robot with the highest score is Mbot, and the educational robot with the lowest score is Lego Boost. According to the item (M = 21), the educational robot with the highest score was Lego Wedo, Lego EV3, and Lego Spike, and the educational robot with the lowest score was Kidoboto. According to the item (M=22), the educational robot with the highest score is Lego Spike, and the educational robot with the lowest score is Kidoboto. Generally, it can be said that the robot with the highest score according to the educational design average scores is the Mbot and the educational robot with the lowest score is the Kidoboto robot. Also, according to the educational design factor average score, the robot with the highest score was Lego Ev3, and the educational robot with the lowest score was the Kidoboto robot. Additionally, according to the Educational Design factor, the education robots, Lego EV3, Lego Wedo, Lego Spike, Lego Boost, and Mbot robots are more suitable in terms of showing error codes on the interface, finding appropriate visual designs, finding remarkable visual characters, checking codes and making the visual design of the robot and interface interesting, for educating pre-school students. The average scores of educational robots, in line with expert opinions, according to the Flexibility and Adaptation factor and its related items, are shown in Table 7.

Table 7. Average scores of educational robots on flexibility and adaptability factors

I	Item	Kidoboto	Lego EV3	MBot	Lego Spike	Lego Wedo	Matatalab	Lego Boost
3	The robot can be easily coded by illiterate students thanks to blocks of simple symbols.	1.5	0	0	0	2	2	0
12	Activities with educational robots are suitable to be associated with real life.	1	2.2	2	2	2.2	.7	2
23	Piece assembly processes are suitable for student level.	.7	1.5	1.2	1.5	1.7	2.5	1
27	Existing parts can be used for different purposes.	.2	2.5	1.2	2.7	2.7	.2	2
28	It provides an opportunity to study and learn on their own.	1	1.7	1.5	1	1.7	2.2	1

Table 7 (Continued). Average scores of educational robots on flexibility and adaptability factors

I	Item	Kidoboto	Lego EV3	MBot	Lego Spike	Lego Wedo	Matatalab	Lego Boost
30	The programming interface is designed in a way that the age groups can easily understand.	.5	1	.5	1	2	1.2	1
31	The activities offered by the educational robot set are compatible with the pre-school program.	1.5	.5	.5	.7	2	2	0
Flexibility and Adaptation		Flexibility and Adaptation	1.4	1.0	1.3	2.1	1.6	1.0

When Table 7 is examined, according to the item (M=3 "The robot can be easily coded by illiterate students thanks to blocks consisting of simple symbols"), the educational robot with the highest scores is Lego Wedo, Matatalab, and the educational robot with the lowest scores Lego EV3, Mbot, Lego Spike, and Lego Boost. According to the item (M=12 "The activities with the educational robot are convenient to be associated with real life"), the educational robot with the highest score is Lego EV3, Lego Wedo, and the educational robot with the lowest score is Kidoboto. According to the item (M=23 "Part assembly operations are suitable for student level."), the educational robot with the highest score is Matatalab, and the educational robot with the lowest score is Kidoboto. According to the item (M=27 "Existing parts can be used for different purposes."), the educational robot with the highest score is Lego Spike and Lego Wedo, and the educational robot with the lowest score is Kidoboto and Matatalab. According to the item (M=28: "It provides the opportunity to self-study and learn."), the educational robot with the highest score is Matatalab, and the educational robot with the lowest score is Kidoboto Lego Spike and Lego Boost. According to the item (M=30: "The programming interface is designed in such a way that the age group can easily understand it."), the educational robot with the highest score was Lego Wedo, and the educational robot with the lowest score was Kidoboto. According to the item (M=31: "The activities offered by the educational robot set are compatible with the pre-school program."), the educational robot with the highest score is Matatalab, and Lego Wedo and the educational robot with the lowest score is Lego Boost. Generally, it can be said that the robot with the highest score in terms of flexibility and adaptability factor averages is Lego Wedo, and the educational robot with the lowest score is the Kidoboto robot. Finally, it can be said that the robot with the highest score in terms of flexibility and adaptability factor average scores is Lego Ev3, and the educational robot with the lowest score is the Kidoboto robot. Additionally, when educational robots are evaluated according to the Flexibility and Adaptation factor due to their features such as being efficiently coded by illiterate students, associating activities with real life, the appropriateness of part joining processes, the availability of parts for different purposes, the presentation of self-study and learning opportunities, the suitability of the programming interface and activities in terms of the usefulness of the programming interface and activities Lego EV3, Lego Wedo, Lego Spike, and Matatalab robots are more appropriate for educating pre-school students. The average scores of educational robots, in line with expert opinions, according to the Support to Learning factor and related items, are shown in Table 8.

Table 8. Average scores of educational robots according to the support to learning factors

I	Item	Kidoboto	Lego EV3	MBot	Lego Spike	Lego Wedo	Matatalab	Lego Boost
24	The robot includes voice instructions.	.2	1.5	0	.5	.2	.5	2
25	The robot includes visual instructions.	.7	2.2	.5	2.2	1.7	2	2
29	The educational robot allows different robot designs that can perform the same function.	0	2.5	1.7	2.7	3	1.2	2

Table 8 (Continued). Average scores of educational robots according to the support to learning factors

I	Item	Kidoboto	Lego EV3	MBot	Lego Spike	Lego Wedo	Matatalab	Lego Boost
8	The interface includes visual instructions.	.7	2.5	1.2	2.5	3	.7	3
9	The interface includes voice instructions.	0	.5	0	0	.2	.7	0
10	It provides opportunities for various activities/tasks.	1	2.5	2.7	2.7	3	1.7	2
4	The educational robot kit provides examples of these activities.	.7	2.7	2.7	3	3	2.7	3
13	Develops creativity skills.	1.2	2.7	2.2	2.5	3	2.2	2
14	The develops problem solving skills.	1.2	2.5	2.2	2.5	2.7	2.5	2
15	Develops algorithmic thinking skills.	1	2.7	2.5	2.7	3	2.7	2
16	Develops psychomotor skills.	1	3	1.5	2.2	2.5	1.5	3
17	Develops collaborative working skills.	.2	1.7	1.2	1.7	1.5	1.2	2
18	It offers several methods for reviewing errors.	0	0	.7	.2	.5	1	0
20	Give appropriate feedback on the tasks performed.	0	.2	0	0,5	.5	0,2	0
Support to Learning		Support to Learning	2.0	1.4	1.9	2.0	1.5	1.8

When Table 8 is examined, according to the item (M=24: "The robot includes voice instructions."), the educational robot with the highest score is Lego Boost, and the educational robot with the lowest score is Mbot. According to the item (M=25: "The robot includes visual instructions."), the educational robot with the highest score is Lego Spike and Lego EV3, and the educational robot with the lowest score is Mbot. According to the item (M=29: "The educational robot makes it possible to design different robots that can perform the same function."), the educational robot with the highest score is Lego Spike, and the educational robot with the lowest score is Kidoboto. According to the item (M=8:" The interface contains visual instructions."), the educational robot with the highest score was Lego Wedo and Lego Boost, and the educational robot with the lowest score was Kidoboto. According to the item (M=9: "The interface includes voice instructions."), the educational robot with the highest score is Matatalab, and the educational robot with the lowest score is Kidoboto, MBOT, Lego Spike, and Lego Boost. According to the item (M=10: "It gives opportunity to various activities/tasks."), the educational robot with the highest score was Lego Wedo, and the educational robot with the lowest score was Kidoboto. The educational robot with the highest score according to the item (M=4: "The educational robot kit provides an example of activity.") is Lego Wedo, Lego Boost, and Lego Spike, and the educational robot with the lowest score was Kidoboto. The educational robot with the highest score according to the item (M=13: "From the services of creativity.") is Lego Wedo, and the educational robot with the lowest score is Kidoboto. The educational robot with the highest score according to the item (M=14: "Doesn't troubleshoot.") was Lego Wedo, and the educational robot with the lowest score was Kidoboto. The educational robot with the highest score according to the item (M=15: "Ignore algorithmic.") was Lego Wedo, and the educational robot with the lowest score was Kidoboto. The educational robot with the highest score according to the item (M=16: "Psycomotor design.") was Lego Boost, and the educational robot with the lowest score was Kidoboto. According to the item, the educational robot with the highest

score (M=17: "Satisfied with collaborative work.") was Lego Boost, and the educational robot with the lowest score was Kidoboto. The educational robot with the highest score according to the item (M=18: "It provides options for reviewing errors.") was Matatalab, and the educational robot with the lowest score was Lego EV3, Lego Boost, and Kidoboto. The educational robot with the highest score according to the item (M=20: "It will be returned to us for assigned missions.") was Lego Wedo, Lego Spike, and the educational robot with the lowest score was Kidoboto, Lego Boost, and Mbot. Finally, it can be said that the robot with the highest score in education was Lego Ev3 and the robot with the lowest score was the Kidoboto robot. Additionally, when educational robots are evaluated according to the Support to Learning factor because of their features, such as the inclusion of audio and visual instructions, enabling different robot designs, the inclusion of audio and visual instructions on its interface, allowing for constructing various activities and examples, providing opportunities for developing 21st-century and psychomotor skills, offering multiple methods for reviewing errors and providing appropriate feedback for the given tasks, it can be said that Lego EV3, Lego Wedo, Lego Spike, Lego Boost, Matatalab, and Mbot robots are more suitable for educating pre-school students.

CONCLUSION and DISCUSSION

Educational robots were evaluated in terms of pedagogical features. Considering the technological integration dimension, Lego EV3, Lego Wedo, Lego Spike, Lego Boost, and Mbot are found to be more suitable for educating pre-school students in terms of setting the characteristic behavior of the robot, using it with other technologies, controlling it through different technologies and using the drag-and-drop interface. Similarly, by examining the educational robots studies by Yang et al. (2022) and O'Brien (2020) at the pre-school level, it has been seen that educational robots with certain features, such as Matatalab and Kidoboto, have positive benefits in terms of technological integration. Additionally, this study concluded that the technological integration of Lego sets, especially Lego EV3, is more valuable than Mbot and other Lego sets. However, although educational robots such as Kidoboto and Matatalab can be used in terms of technological integration, these educational robots need to be further developed with respect to technological integration.

Considering the educational design dimension, we concluded that Lego EV3, Lego Wedo, Lego Spike, Lego Boost, and Mbot robots are suitable for educating pre-school students in terms of the robot's characteristic behavior adjustment, use with other technologies, control via other technologies and the use of drag-and-drop interface. However, considering the educational design dimension, Lego EV3, Lego Wedo, Lego Spike, Lego Boost, and Lego EV3, Lego Wedo, Lego Spike, and Lego Boost Mbot robots are more prominent for educating pre-school students. Furthermore, when similar studies in the literature are examined, it is seen that educational robots such as Lego Wedo, Lego Spike, and Lego EV3, apart from the pre-school group, are more prominent in educational design for different levels (Usengül & Bahçeci, 2020; Tweedale, 2022; McAllister & Glidden, 2022; Korkmaz, 2018), and for the pre-school level, educational robots with features such as Matatalab come to the fore in terms of educational design (Yang et al., 2022). Additionally, this study concluded that the educational design of the Mbot set for pre-school level is more beneficial than other educational robots. However, although educational robots that do not have an interface, such as Kidoboto, can be used in educational settings, these robots need to be developed in terms of educational design.

In terms of flexibility and adaptability dimensions, Lego EV3, Lego Wedo, Lego Spike, and Matatalab robots are found to be more prominent for educating pre-school students due to having the abilities such as to be efficiently coded by illiterate students, the relevance of activities to real-life, the suitability of parts joining processes, the availability of parts for different purposes, the opportunity to self-study and learn, the suitability of the programming interface and activities. Additionally, in this study, the flexibility and adaptability of the Lego Wedo set are found to be more prominent than other educational robots. Although educational robots such as Kidoboto are usable in flexibility and adaptability, they need to be developed in terms of flexibility and adaptation. When similar studies are examined in the literature, it is seen that educational robots are not considered in terms of flexibility or adaptation dimension.

Finally, considering the learning support dimension, due to their features of having audio and visual instructions, allowing for different robot designs, containing audio and visual instructions on the interface, allowing for the production of various activities and examples, providing an opportunity for developing of twenty-first-century skills and psychomotor skills, offering multiple options for reviewing mistakes, Lego EV3, Lego Wedo, Lego Spike, Lego Boost, Matatalab, and Mbot robots are more prominent for educating pre-school students.

Examining the literature reveals that educational robots Lego EV3, Mbot, Matatalab, Lego Spike, and Lego Wedo, which are evaluated to be beyond the pre-school level, come to the fore in terms of the learning support dimension (McAllister & Glidden, 2022); Tweedale, 2022; Khodabandelou & Alhoqani, 2022; Usengül & Bahçeci, 2020; Yang et al., 2022; Korkmaz, 2018; Sáez-López et al., 2019). In this study, the Lego EV3 set stands out more than other educational robots in learning support. Although educational robots such as Kidoboto, which do not allow robot design, have limited activities, and exclude feedback for errors, can be used to support learning, there is an obvious need to be further developed in terms of learning support.

Recommends and Limitations

This study is limited to robots that are widely used in the literature and can be accessed by experts. Additionally, this study was prepared to classify educational robots used only for pre-school students. Therefore, the pedagogical classification of educational robots used for primary, secondary, and high school students can be done in future research.

Funding

This research did not receive any specific grant from the public, commercial, or not-for-profit funding agencies.

Data Availability

The data supporting this study's findings are not openly available because of [reasons of sensitivity, e.g., human data] and are available from the corresponding author upon reasonable request.

Ethics and Conflict of Interest

The authors declare that the work is written with due consideration of ethical standards. The authors declare that they have no competing interests.

REFERENCES

ATC21S (2010). Assessment and teaching of 21st-century skills. Retrieved April 17, 2022, from https://www.cisco.com/c/dam/en_us/about/citizenship/socioeconomic/docs/ATC21S_Exec_Summary.pdf

Atman Uslu, N., Öztüre Yavuz, G., & Koçak Usluel, Y. (2022). A systematic review study on educational robotics and robots. *Interactive Learning Environments, 1-25*. https://doi.org/10.1080/10494820.2021.2023890

Bravo, F. A., González, A. M., & González, E. (2017). A review of intuitive robot programming environments for educational purposes. In 2017 IEEE 3rd Colombian Conference on Automatic Control (CCAC) (p. 1-6). IEEE. https://doi.org/10.1109/CCAC.2017.8276396

Çetin, M., & Çetin, G. (2021). A Critical Outlook on MoNE Early Childhood Education Curriculum in terms of 21st-century Skills. *Journal of Education for Life, 35*(1), 235-255. https://doi.org/10.33308/26674874.2021351258

Creswell, J. W. (2017). *30 essential skills for qualitative researchers*. Anı Publishing.

Simsar, H. D. A., & Yalçın, V. (2021). Examining 21st-century skills of 3-6 years old children in terms of some variables. *e-Kafkas Journal of Education Research, 8,* 281-303. https://doi.org/10.30900/kafkasegt.941467

Fessakis, G., Gouli, E., & Mavroudi, E. (2013). Problem solving by 5–6 years old kindergarten children in a computer programming environment: A case study, *Computers & Education, 63*, 87-97. https://doi.org/10.1016/j.compedu.2012.11.016

ISTE (2019). The ISTE (International Society for Technology in Education) National Educational Technology Standards (NETS-S) and Performance Indicators for Students. Retrieved April 17, 2022, from http://www.iste.org/standards/nets-for-students

Kalemkuş, F., & Bulut Özek, M. (2021). Research Trends of the 21th Century Skills: 2000-2020 (January). *MANAS Journal of Social Studies, 10*(2), 878-900. https://doi.org/10.33206/mjss.774848

Katz, L. G. (2010). STEM in the early years. SEED (STEM in early education and development) Conference, Cedar Falls, IOWA. Retrieved from http://ecrp.illinois.edu/beyond/seed/katz.html

Kaya, M., Korkmaz, Ö., & Çakır, R. (2020 The effect of gamified robotics activities on the problem solving and the computational thinking skills of the secondary school students. *Ege Journal of Education, 21*(1), 54-70. https://doi.org/10.12984/egeefd.588512

Khodabandelou, R., & Alhoqani, K. (2022). The effects of WeDo 2.0 robot workshop on Omani grade 5 students' acquisition of the computational thinking concepts and acceptance of the robot technology. *Education 3-13*, 1-17. https://doi.org/10.1080/03004279.2022.2041685

Kocaçil, S. (2020). *Programmable educational toy robot design and its use in pre-school* [Unpublished master's thesis]. Afyon Kocatepe University.

Korkmaz, Ö. (2018). The effect of scratch-and lego mindstorms Ev3-Based programming activities on academic achievement, problem-solving skills and logical-mathematical thinking skills of students. *MOJES: Malaysian Online Journal of Educational Sciences, 4*(3), 73-88.

Korkmaz, Ö., Acar, B., Çakır, R., Erdoğmuş, F. U., & Çakır, E. (2019). Educational robot sets with science and technology course basic Machinery of the secondary school 7th class students' stem skill Levels and the effect of the lesson attitudes. *Educational technology theory and practice, 9*(2), 372-391. https://doi.org/10.17943/etku.518215

Marzano, G., & Zorzi, S. (2022). Autism and creativity: a social robotics application. In society. integration. education. *Proceedings of the International Scientific Conference* (Vol. 1, pp. 685-696). https://doi.org/10.17770/sie2022vol1.6825

McAllister Ed D, D. A., & Glidden, J. L. (2022). *Learning Robotics Concepts with Lego Spike Essential: Data Collection 2021 with Pre-service Teachers.* https://doi.org/10.47646/cmd.2020.180

Memiş, T. (2020). Özel yeteneklilerin eğitiminde lego ev3 robotlarla tam sayılarda işlemlere yönelik bir etkinlik çalışması [An activity development study for integer operations with lego ev3 robots in the education of special talents]. *Journal of Children and Civilization, 5*(10). http://dx.doi.org/10.47646/CMD.2020.180

Miles, M. B., & Huberman A. M. (1994) *Qualitative data analysis: An expanded sourcebook*. Sage Publications, Thousand Oaks, CA.

Ministry of National Education (2013). *Pre-school curriculum*. Ankara. Retrieved April 17, 2022, from https://tegm.MONE.gov.tr/dosya/okuloncesi/ooproram.pdf

Negrini, L., & Giang, C. (2019). How do pupils perceive educational robotics as a tool to improve their 21st-century skills?. *Journal of e-Learning and Knowledge Society, 15*(2), 77-87. https://doi.org/10.20368/1971-8829/1628

O'Brien, B. (2020). How to choose the right type of robot for your classroom. Meet Edison. Retrieved April 18, 2022, from https://meetedison.com/how-to-choose-the-right-robot-for-your-classroom/

P21 (2019). P21 framework definitions. Retrieved April 17, 2022, from https://static.battelleforkids.org/documents/p21/P21EarlyChildhoodFramework.pdf

Paucar-Curasma, R., Villalba-Condori, K., Arias-Chavez, D., Le, N. T., Garcia-Tejada, G., & Frango-Silveira, I. (2022). Evaluation of Computational Thinking using four educational robots with primary school students in Peru. *Education in the Knowledge Society, 23.* https://doi.org/10.14201/eks.26161

Pei, Z., & Nie, Y. (2018). Educational robots: Classification, characteristics, application areas and problems. *In 2018 Seventh International Conference of Educational Innovation through Technology (EITT) (pp. 57-62). IEEE.* https://doi.org/10.1109/eitt.2018.00020

Polat, Ö., & Bardak, M. (2019). STEM approach in early childhood. *International Journal of Social Science Research, 8*(2), 18-41.

Sáez-López, J. M., Sevillano-García, M. L., & Vazquez-Cano, E. (2019). The effect of programming on primary school students' mathematical and scientific understanding: educational use of mBot. *Educational Technology Research and Development, 67*(6), 1405-1425. https://doi.org/10.1007/s11423-019-09648-5

Schina, D., Esteve-González, V., & Usart, M. (2021). An overview of teacher training programs in educational robotics: characteristics, best practices and recommendations. *Education and Information Technologies, 26*(3), 2831-2852. https://doi.org/10.1007/s10639-020-10377-z

Serholt, S. (2018). Breakdowns in children's interactions with a robotic tutor: A longitudinal study. *Computers in Human Behavior, 81*, 250-264. https://doi.org/10.1016/j.chb.2017.12.030

Tang, A. L., Tung, V. W. S., & Cheng, T. O. (2020). Dual roles of educational robotics in management education: Pedagogical means and learning outcomes. *Education and Information Technologies, 25*(2), 1271-1283. https://doi.org/10.1007/s10639-019-10015-3

Tuğluk, M. N. & Özkan, B. (2019) Analysis of MoNE 2013 pre-school education program in terms of 21st-century skills. *Journal of Primary Education, 1*(4), 29-38.

Tweedale, J. W. (2022). Using Lego EV3 to explore robotic concepts in a laboratory. *International Journal of Advanced Intelligence Paradigms, 21*(3-4), 330-347. https://doi.org/10.1504/ijaip.2022.10046237

Usengül, L., & Bahçeci, F. (2020). The effect of lego WeDo 2.0 education on academic achievement and attitudes and computational thinking skills of learners toward science. *World Journal of Education, 10*(4), 83-93. https://doi.org/10.5430/wje.v10n4p83

Veselovská, M., & Mayerová, K. (2017, April). LEGO WeDo curriculum for lower secondary school. *In International Conference on Robotics and Education RiE 2017 (pp. 53-64).* Springer, Cham. https://doi.org/10.1007/978-3-319-62875-2_5

Xia, L., & Zhong, B. (2018). A systematic review on teaching and learning robotics content knowledge in K-12. *Computers & Education, 127*, 267-282. https://doi.org/10.1016/j.compedu.2018.09.007

Yang, W., Ng, D. T. K., & Gao, H. (2022). Robot programming versus block play in early childhood education: Effects on computational thinking, sequencing ability, and self-regulation. *British Journal of Educational Technology, 53*(6), 1817-1841. https://doi.org/10.1111/bjet.13215

Yıldırım, R., & Ortak, Ş. (2021). Determining the level of using 21st-century learning and innovation skills of secondary school students. *Turkish Studies-Education Sciences, 16*(6), 2683-2701. https://dx.doi.org/10.7827/TurkishStudies.51668

ANNEX-1

Pedagogical Characteristics of Educational Robots Rubric

Factor	Item	Features
Flexibility and Adaptation	**3**	The robot can be easily coded by illiterate students thanks to blocks of simple symbols.
	12	Activities with educational robots are suitable to be associated with real life.
	23	Piece assembly processes are suitable for student level.
	27	Existing parts can be used for different purposes.
	28	It provides the opportunity to study and learn on their own.
	30	The programming interface is designed in a way that the age group can easily understand.
	31	The activities offered by the educational robot set are compatible with the pre-school program.
Technological Integration	**1**	Settings that affect the characteristic behavior of the robot can be adjusted.
	11	It is possible to use other technologies (smartphones, 3D printers, etc.) to carry out various activities.
	26	It is controllable by various technologies (Tablet, computer, remote control, etc.).
	5	The drag-and-drop method is used in the interface.
Support to Learning	**24**	The robot includes voice instructions.
	25	The robot includes visual instructions.
	29	The educational robot allows different robot designs that can perform the same function.
	8	The interface includes visual instructions.
	9	The interface includes voice instructions.
	10	It provides opportunities for various activities/tasks.
	4	The educational robot kit provides examples of activities.
	13	Develops creativity skills.
	14	Develops problem solving skills.
	15	Develops algorithmic thinking skills.
	16	Develops psychomotor skills.
	17	Develops collaborative working skills.
	18	It offers several methods for reviewing errors.
	20	Gives appropriate feedback on the tasks performed.
Educational Design	**2**	Error codes or messages are displayed on the interface.
	6	The interface has appropriate visual designs.
	7	There are remarkable visual characters in the interface.
	19	It checks whether the codes work properly for the purpose or not.
	21	The visual design of the robot is interesting.
	22	The visual design of the interface is interesting.

IOJPE

ISSN: 1300 – 915X
www.iojpe.org

International Online Journal of Primary Education *2023, volume 12, issue 1*

EXAMINATION OF THE RELATIONSHIP BETWEEN ACADEMIC GRIT AND THEIR ACADEMIC SUCCESS FOURTH GRADE STUDENTS IN PRIMARY SCHOOL

Nermin TEMEL
PhD Student, Ondokuz Mayıs University, Samsun, Turkey
ORCID: https://orcid.org/0000-0003-0307-6265
nermin.oztp@gmail.com

Sezgin TEMEL
PhD Student, Ondokuz Mayıs University, Samsun, Turkey
ORCID: https://orcid.org/0000-0001-8317-8629
temel_sezgin@hotmail.com

Ceren ÇEVİK KANSU
Assist.Prof.Dr., Ondokuz Mayıs University, Samsun, Turkey
ORCID: https://orcid.org/0000-0003-4444-7165
ceren.ckansu@omu.edu.tr

Received: April 02, 2022 **Accepted:** February 24, 2023 **Published:** March 31, 2023

Suggested Citation:
Temel, N., Temel, S., & Çevik Kansu, C. (2023). Examination of the relationship between academic grit and their academic success fourth grade students in primary school. *International Online Journal of Primary Education (IOJPE), 12*(1), 42-60. https://doi.org/10.55020/iojpe.1097470

Abstract

This study aims to examine the relationship between the academic achievement of primary school students and their academic grit. It also tried to determine whether the academic grit of the students affected various variables. The research is a quantitative study based on the relational screening model. The study sample consists of 400 fourth-grade students in the center of Sivas, which was determined by the proportional stratified method. Personal information form and Academic Perseverance Scale were used as data collection tools. According to the study results, a significant relationship was found between academic achievement and academic grit. This relationship was found to be significant, moderate, and positive. In addition, the study determined that academic perseverance differed significantly according to gender, father's education status, socioeconomic status, and pre-school education status. However, it was observed that academic perseverance did not differ according to the number of siblings and the mother's educational status.

Keywords: Primary school, academic grit, academic success, fourth-grade student.

INTRODUCTION

Education helps individuals adapt to life in all stages of life. Individuals can keep up with the adaptation process to the extent that they can use their abilities. Education aims to create behavioral changes in individuals by supporting their cognitive, social, emotional, and moral development (Akyuz, 2012). The aspect of education related to cognitive development is associated with academic success. Therefore, it can be considered that the cognitive development of a student with high academic success is also developed at a desired level. Rivnik, Hanuskek, & Kain (2005) defined academic success as the attainment of targeted goals in terms of education and suggested that it covers behavioral changes that occur in individuals apart from psychomotor and emotional development.

Academic success, one of the most significant indicators of knowledge acquisition, is necessary for individuals to find jobs, advance their careers and attain the things they value. Therefore, the factors that affect academic achievement have been examined by many researchers (Reraki, Celik, & Saricam, 2015). Many factors affecting academic success, including education provided by the teacher, the student's efforts, school climate, the family's attitude towards education, participation of

the family in education at home or school, the environment where the school is located, the developmental period that the child is going through, the educational status of parents, socioeconomic level, character traits of the student and gender (Jeynes, 2011).

The reason why individuals with the same intelligence level have a different level of academic success (apart from these factors) has long been a topic of research for pedagogues and psychologists. It is seen in the studies that the determination of the individual is a strong factor in increasing academic success (Credé, Tynan, & Harms, 2017). Allen, Kannangara, and Carson (2021), Clarck and Malecki (2019), Jiang et al. (2019), and Lam and Zhou (2019) examined the connection between academic grit and success; Datu, Yuen, and Chen (2017) studied grit and self-sufficiency in academic, career and skill development. Meyer et al. (2020) searched the relationship between grit and endurance. Determination is another factor considered as important as intelligence for academic success. Grit is the effort exerted despite failures and problems and a variable that requires working keenly against challenges while maintaining interest in the subject. In sum, success is a product of talent and effort (Datu, Yuen, & Chen, 2017; Duckworth, Peterson, Matthews, & Kelly, 2007; Sturman & Zappala-Piemme, 2017).

Grit is an indispensable variable for success (Al-Mutawah & Fateel, 2018; Bozgun & Basgul, 2018). Academic determination represents the desired quality of academic behaviors required for both short- and long-term academic success and the acquisition of a degree (Arslan, Akin, & Citemel, 2013; Ozhan & Boyaci, 2018). Grit can be defined as self-commitment to achieve a certain goal in the long run (Mohan & Kaur, 2021). Grit involves two factors: degree of effort and consistency of interest. The first one refers to how persistently people facing difficulties make an effort. Consistency of interest reflects the tendency to support a similar line of interest for an extended period (Duckworth & Quinn, 2009). Apart from these two dimensions, it is thought that grit, representing one's ability to adapt to changing conditions in life in a practical way, is also associated with adapting to situations, expecting challenges, accepting changes, being flexible, and overcoming new challenges (Datu et al., 2017). More grit individuals are more persistent and hardworking, are more motivated to set long-term goals and projects, and can better focus (Bazelais, Lemay, & Doleck, 2016).

While grit emphasizes individual differences that lead to success, it is influenced by general achievement criteria. Being aware of these achievement criteria, it is substantial for educators to know the grit skills levels of their students (Mohan & Kaur, 2021). The issue of academic stability has been studied by researchers in recent years. These studies are included to determine academic success and performance (Lam & Zhau, 2019). As a notion that has recently emerged, academic grit is also regarded as a feature of motivation that partly determines the approaches and strategies related to academic tasks (Alhadabi et al., 2019).

Grounds and Significance of the Research

The literature review reveals that there are studies performed to analyze the association between academic grit and success (Christopoulou et al., 2018; Dixson, 2019; Duckworth & Quinn, 2009; Akos & Kretchmar, 2017; Clark & Malecki, 2019; Dixson et al., 2016; Duckworth et al., 2007; Hodge, Wright, & Bennett, 2017; Hwang, Lim, & Ha, 2017; Hinojosa, Lu, & Vela, 2019; Jiang et al., 2019; Kleiman, Adams, Kashdan, & Riskind, 2013; Perez, 2015; Reraki et al., 2015; Rimfeld et al., 2016; Rogers, Strayhorm, 2014; Townsend, & Lindner, 2004; Tucker-Drob et al., 2016; Weisskirtch, 2016; West et al., 2016; Wolters & Hussain, 2015). Looking at the literature, Dixson (2019), Gümüş (2021), Duckworth and Quinn (2009), and Serin (2021b) stated that high school students, secondary school students by Clark and Malecki (2019), Rojas and Usher (2012), Acar (2021), Ural and Çınar (2014), Borton and Grelle (2013); It was observed that the grits of undergraduate students were examined by Reraki, Çelik, and Sarıçam (2015), Wolter and Hussain (2015), Porter (2019). The difference between the study from these studies is that it examines the academic grit of primary school 4th-grade students. When the studies are examined, there are also studies examining the perseverance of primary school students (Eryiğit, 2022; Jiang et al., 2019). The difference between the study from these studies is that it examines the relationship of academic grit with success and its

effect on various variables. In addition, it was seen that most of the studies on academic grit in the literature were not conducted with primary school students.

However, most of these studies were not carried out with primary school students, and it can be suggested that research is limited since academic grit is a new field (Cohen, 2015). Literature review shows that analysis of academic grit in terms of various variables is also limited. Studies carried out with lower age groups (Postigo, Cuesta, Fernández-Alonso, García-Cueto, & Mu˜niz, 2021) suggest that failure in school, especially as age increases increases as a result of a decrease in academic grit. Therefore, it is necessary to take the necessary steps to encourage and reinforce academic grit in these groups. Because it is thought that academic grit should be examined by researchers (Costa & Faria, 2018; Lou & Noels, 2019). In addition, researchers suggest that academic perseverance may mediate perceptions and beliefs about school work and success (Kaya & Karakoc, 2022). In this regard, the research is significant in terms of analyzing the relationship between academic grit and the success of 4th-grade students and analyzing academic grit in relation to various variables.

Grit is influential in determining which individuals are persistent enough to stay on track in the education process. Therefore, it seems increasingly important to investigate the trends that affect students' grit and achievement results (Bazelais, Lemay, & Doleck, 2016). Being determined significantly affects academic learning. That's why many researchers and educators try to encourage courage to increase students' academic success. However, the studies do not provide complete information on the extent to which academic grit can explain success (Lam & Zhou, 2019). In addition, considering that academic success is vital in education, it is crucial to analyze academic grit, which is thought to affect academic success.

The Aim of the Research

This research aims to determine the relationship between academic grit and the academic success of fourth-grade students. Answers have been sought for the following questions in line with this aim:

Sub-Problems

1. What are the academic grit and success levels of fourth-grade students?

2. Is there a significant relationship between academic grit and the academic success of fourth-grade students?

3. Does the academic grit of fourth-grade students differ significantly based on the;

- ✓ gender,
- ✓ mother’s educational status,
- ✓ father’s educational status,
- ✓ socioeconomic level of the area where the school is located,
- ✓ number of siblings,
- ✓ status of pre-school education.

METHOD

This part includes the research model, universe and sample, data collection tools, implementation process, and data analysis.

Research Model

This research uses a survey model, a quantitative study based on the relational screening model. In the correlational survey model, information is collected from a group of people to identify some features of the universe that the relevant group is a part of. The primary way of collecting information is to ask questions; the answers given to these questions by group members constitute the study’s data. A cross-sectional study aims to collect information from a sample from a pre-determined universe

(Fraenkel, Wallen, & Hyun, 2012, p. 393). In a cross-sectional survey design, the researcher collects data simultaneously. In cross-sectional studies, choosing a sample as large as possible is essential to display the characteristics that resemble the target universe (Creswell, 2012).

Population and Sample

The research population consists of 5062 fourth-grade students who study in state primary schools in the city center of Sivas in the academic year 2020-2021. Four hundred (400) primary school students were selected using the proportional stratified sampling technique study in different socioeconomic regions of Sivas province. In determining the sample group, information was requested from the Turkish Statistical Institute (TSI) regarding the socioeconomic level of the neighborhoods in the city center of Sivas. As a result, TSI grouped the neighborhoods in the city center of Sivas based on their socioeconomic status as lower, middle, and upper. Proportionate stratified is a sampling method that aims to determine the population's lower groups and ensure that they are represented in the sample in line with their proportion in the universe (Buyukozturk et al., 2014, p. 86). In the population consisting of 5062 people, it was observed that 1200 people were at the upper socioeconomic level, 2854 were at the middle socioeconomic level, and 1008 were at the lower socioeconomic level, according to the region where the school is located. According to this, 96 people were chosen randomly, with a rate of 24% for the upper socioeconomic level, 224 people with a rate of 56% for the middle socioeconomic level, and a rate of 20% for the lower socioeconomic level, and 80 people were randomly selected.

Table 1 indicates the sample's data distribution based on their various demographic information.

Table 1. Demographic information of the students

Features		f	%
Socioeconomic Level	Upper	96	24
	Middle	224	56
	Lower	80	20
Gender	Male	184	46
	Female	216	54
Mother's Educational Status (MES)	Primary	99	24.8
	Secondary school	112	28
	High school	100	25
	Undergraduate and above	89	22.2
Father's Educational Status (FES)	Primary school	54	13.5
	Secondary school	78	19.5
	High school	143	35.8
	Undergraduate and above	125	31.2
Number of Siblings	1	137	34.3
	2	106	26.4
	3 and above	157	39.3
Status of Pre-School Education	Yes	275	68.7
	No	125	31.3

Table 1 shows that the socioeconomic level of the regions where the school is related is upper for 24% of the students (n=96), middle for 56% of the students (n=224), lower for 20% of the students (n=80); 46% of the students are male (n=184), and 54% are female (n=2016); the educational status of the mother is the primary school for 24,8% of the students (n=99), secondary school for 28% (n=112), high school for 25% (n=100), and undergraduate or above for 22.2% (n=89); the educational status of the father is the primary school for 13,5% of the students (n=54), secondary school for 19,5% (n=78), high school for 35,8% (n=143), undergraduate and above for 31.2% (n=125); 34,4% of the students (n:137) have 1 sibling, 26,4% (n:106) has 2 siblings, and 39,3% (n=157) 3 and more siblings; 68.7% of the students (n=275) received pre-school education, and 31.3% (n=125) did not receive pre-school education.

Data Collection Tools

1. Personal Information Form

The researchers created this form to determine the gender, school, mother's and father's educational status, number of siblings, the status of pre-school education, and overall school report grades (success average) for the first semester of the academic year 2020-2021 for the students who participated in the research. The student's academic achievement scores represent the average grade point average at the end of the first semester of the fourth year. These grades consist of the student's average scores in the exam for all courses during a semester and their performance. The data obtained using the form can be determined in light of the literature review and can affect academic grit.

2. Academic Grit Scale

The scale developed by Rojas, Reser, Usher, and Toland (2012) to determine the academic grit level of fourth-grade and secondary school students was adapted to Turkish by Bozgun and Basgul (2018). The scale consists of 10 items and a single dimension. The first and ninth items of the scale are negative. If the first and eighth items have the same reply, it can be deduced that the scale has not been read; thus, the relevant data can be removed from the dataset (Rojas et al., 2012). It is a Likert-type scale consisting of the following replies: "I strongly disagree," "I disagree," I am neutral," I agree," and "I strongly agree." The lowest score that can be obtained from the scale is 10, and the highest is 50. Lower scores indicate that the student has low academic grit, and higher scores indicate that the student has high academic grit. Cronbach internal consistency coefficient is .85 in the original form of the scale and .84 in the Turkish form. Within the scope of the validity study of the scale, it was determined that the fit index values of the Confirmatory Factor Analysis had acceptable and perfectly varying values (Bozgun & Basgul, 2018). This study calculated Cronbach's alpha internal consistency coefficient as .89.

Implementation Process

First of all, administrators in randomly selected schools were interviewed. Institutional and scale usage permissions were obtained, and the necessary information was given to the people to whom the application would be made. In addition, the fourth-grade teachers in the schools where the data will be collected were also interviewed. Their contributions were requested to fill out the forms carefully to collect the data reliably. In the implementation period, data were collected remotely as the academic year 2020-2021 was generally carried out online due to the pandemic. The academic grit scale was transferred to Google Forms, and relevant links were sent to fourth-grade teachers working in state primary schools in Sivas. The teachers were asked to share the links in parent WhatsApp groups. The parents were informed that the forms also needed to be filled out by the students. The data collection process was completed in April-May of the academic year 2020-2021.

Analysis of Data

The research data were analyzed using a statistical package program in the computer environment. In the data analysis, it was initially determined whether the grades obtained by the students in the measurement tool exhibited normal distribution. To check whether the data exhibited normal distribution, Kolmogorov-Smirnov (K-S) test and Shapiro-Wilk (S-W) test were carried out, and skewness and kurtosis values, Z scores and histogram graphics were examined. Examination results showed that the data did not exhibit a normal distribution.

In the data analysis, the Mann Whitney U test was used to compare the student's academic grit scores based on gender and status of pre-school education. Kruskal Wallis H test and Jonckheere-Terpstra test, which are non-parametric tests, were used to compare the student's academic grit scores based on the educational status of the mother and father, the socioeconomic level of the region where the school is located and the number of siblings. Mann Whitney U test was used to determine between which groups there was a significant difference. The relationship between the student's academic grit and academic success was determined by calculating the Spearman Rank Difference Correlation Coefficient. P values lower than .05 were regarded as statistically significant in the research.

IOJPE
ISSN: 1300 – 915X
www.iojpe.org
International Online Journal of Primary Education 2023, volume 12, issue 1

FINDINGS

This part includes statistical analyses performed to test the sub-problems of the research and the findings obtained in these analyses.

Table 2 shows the findings demonstrating the academic grit and success level for primary school fourth-grade students.

Table 2. Results on the descriptive statistics of the students' academic grit and academic success

Variables	n	Lowest	Highest	Mean	Std.Dev.	K-S/S-W
Academic Grit	400	13.0	50.0	40.18	8.78	.00/.00
Academic Success	400	60.0	100	92.36	8.93	.00/.00

Table 2 shows that the average score for the student's academic grit is 40.18. Based on this result, the academic grit is high. However, it can also be stated that the student's academic grit scores were not distributed normally (p>.05). It was spied on that the average score for the student's academic success was 92.36. Based on this result, the student's academic success is high. In addition, it was observed that the student's academic success scores were not distributed normally (p<.05).

The changes that occurred in the student's academic grit and academic success scores were examined. For this purpose, the arithmetic average, standard deviation, and normality values of the students' academic grit skill scores and academic success scores (Kolmogorov-Smirnov/Shapiro-Wilk) were evaluated. Table 3 shows the descriptive statistics regarding the students' academic grit skill scores and academic success scores.

Table 3. Descriptive statistics regarding the students' academic grit scores and academic success scores

Score	n	Mean	Std.Dev.	K-S/S-W
Academic Grit Score	400	40.18	8.77	.00/.00
Academic Success Score	400	92.36	8.93	.00/.00

Table 3 shows the average ($\overline{X}$ =40.18) and standard deviation (S=8.77) of the student's academic grit scores and the average ($\overline{X}$ =92.36) and standard deviation (S=8.93) of their academic success scores. It can also be seen that the student's academic grit and success scores (K-S= 0.00, S-W= 0.00, p<.05) do not exhibit a normal distribution.

As the students' academic grit scores and academic success scores do not exhibit normal distribution, the Spearman Rank Difference Correlation analysis was performed to examine the relationship. Analysis results are shown in Table 4.

Table 4. Correlation between the academic grit score and academic success score

Variables		Academic Grit Skill Score	Academic Success Score
Academic Grit Score	r_s	1.00	.294
	p	-	00*
Academic Success Score	r_s	.294	1.00
	p	.00*	-

*p<.01

Table 4 shows that, based on the Spearman Rank Difference Correlation analysis, there is a positive and med-level relationship between the students' academic grit scores and academic success scores (r_s=.294, p<.05). It was identified that the determination coefficient is $Rs^2=(.294)^2=.09$. Accordingly, 9% of the total variability in students' academic grit originates from their academic success. The remaining variance of 91% originates from other variables.

The changes in the student's academic grit scores concerning gender were examined. For this purpose, the arithmetic average, standard deviation, and normality values of the students' academic

grit skill scores based on gender (Kolmogorov-Smirnov/Shapiro-Wilk) were evaluated. Table 5 shows the descriptive statistics regarding the students' academic grit skill scores based on gender.

Table 5. Distribution of students' academic grit scores by gender

Score	Gender	n	Mean	Std.Dev.	K-S/S-W
Academic Grit	Male	184	39.28	8.92	.00/.00
	Female	216	40.94	8.59	.00/.00

Table 5 shows the average ($\overline{X}$ = 40.94) and standard deviation (S= 8.59) of the academic grit scores of female students and the average ($\overline{X}$ =39.28) and standard deviation (S=8.92) of the academic grit scores of male students. It can also be seen that the academic grit scores of female students (K-S=.00, S-W=.00, p<.05) and male students (K-S=.00, S-W=.00, p<.05) do not exhibit a normal distribution. Based on these results, whether the students' academic grit scores vary based on gender was analyzed using the Mann-Whitney U test, and the results were evaluated. Analysis results are shown in Table 6.

Table 6. Results of Mann Whitney U test for the students' academic grit based on gender

Test	Gender	n	Rank Average	Rank Sum	U	p	r
Academic Grit	Male	184	186.96	34400.50	17380.50	.03*	.10
	Female	216	212.03	45799.50			

*p<.05

Tablo 6 shows that the student's academic grit scores vary significantly based on gender (U=17380.50, Z=-2.165, p<.05, r=.10). The academic grit scores of female students (median=43, n=216) are higher than male students (median=41, n=184). The effect size calculated for this data is low.

The changes in the student's academic grit scores based on the mother's educational status were analyzed. For this purpose, the arithmetic average, standard deviation, and normality values (Kolmogorov-Smirnov/Shapiro-Wilk) of the student's academic grit scores based on the Mother's Educational Status (MES) were evaluated. Table 7 shows the descriptive statistics of the academic grit scores based on the MES.

Table 7. Descriptive statistics of the academic grit scores based on the MES

Score	MES	n	Mean	Std.Dev.	K-S/S-W
Academic Grit	Primary school	99	39.62	8.37	.00/.00
	Secondary school	112	39.37	9.05	.00/.00
	High school	100	40.16	9.06	.00/.00
	Undergraduate and above	89	41.83	8.45	.00/.00

Table 7 shows the average ($\overline{X}$ = 39.62) and standard deviation (S= 8.37) of the academic grit scores for the students whose MES is primary school; the average ($\overline{X}$ =39.37) and standard deviation (S=9.05) of the academic grit scores for the students whose MES is secondary school; the average ($\overline{X}$ = 40.16) and standard deviation (S=9.06) of the academic grit scores for the students whose MES is high school; and the average ($\overline{X}$ =41.83) and standard deviation (S=8.45) of the academic grit scores for the students whose MES is undergraduate and above. In addition, as the academic grit scores (K-S= .00, S-W=.00, p <.05) do not exhibit normal distribution for the students whose MES is a primary school, secondary school, high school, and undergraduate and above, Kruskal Wallis H Test was performed for analysis. Table 8 shows the analysis results.

Table 8. Kruskal Wallis H test results for the students' academic grit scores based on the MES

Test	MES	n	Rank Average	Df	H	p
Academic Grit	Primary S.	99	186.86	3	7.24	.06
	Secondary S.	112	190.32			
	High S.	100	201.10			
	Undergraduate and above	89	227.81			

Table 8 shows that the student's academic grit scores do not exhibit a significant difference based on the educational status of the mother ($H_{(3)}$=7.24, p>.05).

The changes in the student's academic grit scores based on the Father's Educational Status (FES) were examined. For this purpose, the arithmetic average, standard deviation, and normality values (Kolmogorov-Smirnov/Shapiro-Wilk) of the student's academic grit scores based on the FES were evaluated. Table 9 shows the descriptive statistics regarding the students' academic grit scores based on the FES.

Table 9. Descriptive statistics of the students' academic grit scores based on the FES

Score	FES	n	Mean	Std.Dev.	K-S/S-W
Academic Grit	Primary S.	54	39.43	8.93	.57/.00
	Secondary S.	78	38.83	9.13	.00/.00
	High S.	143	39.84	8.86	.00/.00
	Undergraduate and above	125	41.72	8.25	.00/.00

Table 9 shows the average ($\overline{X}$ =39.43), and standard deviation (S=8.93) of the academic grit scores for the students whose FES is a primary school; the average ($\overline{X}$ =38.83) and standard deviation (S=9.13) of the academic grit scores for the students whose FES is a secondary school; the average ($\overline{X}$ =39.84) and standard deviation (S=8.86) of the academic grit scores for the students whose FES is high school; the average ($\overline{X}$ =41.72) and standard deviation (S=8.25) of the academic grit scores for the students whose FES is undergraduate and above. It can also be seen that the academic grit scores of the students whose FES is a primary school (K-S= .57, S-W=.00, p<.05) and the academic grit scores of the students whose FES is a secondary school, high school, and undergraduate and above (K-S=.00, S-W=.00, p<.05) do not exhibit a normal distribution. Therefore, whether the academic grit scores of the students varied based on the FES was analyzed using the Kruskal Wallis H Test. Table 10 shows the analysis results.

Tablo 10. Kruskal Wallis H test results for the students' academic grit scores based on the FES

Test	FES	n	Rank Average	Df	H	p	r
Academic Grit	Primary S.	54	186.60	3	7.96	.04*	.13
	Secondary S.	78	183.06				
	High S.	143	194.95				
	Undergraduate and above	125	223.74				

*p<.05

Table 10 shows that the student's academic grit scores vary significantly based on the educational status of the father ($H_{(3)}$=7.96, p<.05). Std. J-T Statistics value was found to be 2.66 according to the Jonckheere-Terpstra Test. Therefore, the academic grit scores increase as the father's educational status increases, and the students' academic grit scores decrease as the father's educational status decreases. The difference is significant at .05 (J=32127.00, Z=2.66, p<.05, r=.13). Therefore, the effect of the FES on the students' academic grit is low.

As there are significant differences between the groups, the Mann-Whitney U test was used to analyze which groups these differences stem from. Table 11 shows the analysis results.

Table 11. Comparison of the students' academic grit based on the FES

Test	FES	n	Rank Average	Rank Sum	U	p	r
Academic Grit	Primary	54	67.15	3626.00	2071.00	.87	-
	Secondary	78	66.05	5152.00			
	Primary	54	95.23	5142.50	3657.50	.57	-
	High School	143	100.42	14360.50			
	Primary	54	79.22	4278.00	2793.00	.06	-
	Undergraduate and above	125	94.66	11832.00			
	Secondary	78	106.87	8335.50	5254.50	.47	-
	High School	143	113.26	16195.50			
	Secondary	78	89.15	6953.50	3872.50	.01*	.17
	Undergraduate and above	125	110.02	13752.50			
	High School	143	125.27	17913.50	7617.50	.03*	.13
	Undergraduate and above	125	145.06	18132.50			

*p<.05

Table 11 shows that there is not a significant difference between the academic grit of the students whose FES is a primary school and the academic grit of those whose FES is a secondary school (U=2071.00 p>.05); the academic grit scores of the students whose FES is a primary school and those whose FES is high school (U=3657.50, p>.05), the academic grit scores of the students whose FES is a primary school and those whose FES is undergraduate and above (U=2793.00, p>.05), the academic grit scores of the students whose FES is a secondary school and those whose FES is high school (U=5257.50, p>.05).

It was found that there is a significant difference between the academic grit scores of the students whose FES is a secondary school and those whose FES is undergraduate and above (U=3872.50, p<.05, r=0.17). In addition, the academic grit scores of the students whose FES is undergraduate and above (median=44.00) are higher than those whose FES is a secondary school (median=41.00). However, the effect size of this difference is small.

It was found that there is a significant difference between the academic grit scores of the students whose FES is high school and those whose FES is undergraduate and above (U=7617.50, p<.05, r=0.13). In addition, the academic grit scores of the students whose FES is undergraduate and above (median=44.00) are higher than those whose FES is high school (median=42.00). However, the effect size of this difference is small.

The changes in the academic grit scores based on the socioeconomic level of the region where the school is located were examined. For this purpose, the arithmetic average, standard deviation, and normality values (Kolmogorov-Smirnov/Shapiro-Wilk) of the student's academic grit scores based on their socioeconomic level were examined. Table 12 shows the descriptive statistics of the student's academic grit scores based on their socioeconomic levels.

Table 12. Descriptive statistics of the students' academic grit scores based on their socioeconomic levels

Score	Socioeconomic Level	n	Mean	Std.Dev.	K-S/S-W
Academic Grit	Upper	96	42.38	6.49	.00/.00
	Middle	224	39.82	9.24	.00/.00
	Lower	80	38.53	9.39	.00/.00

Table 12 shows the average ($\overline{X}$ = 42.38) and standard deviation (S=6.49) of the academic grit scores for the students whose socioeconomic level is upper; the average ($\overline{X}$ =39.82) and standard deviation (S=9.24) of the academic grit scores for the students whose socioeconomic level is middle; and the average ($\overline{X}$ = 38.53) and standard deviation (S=9.39) of the academic grit scores for the students whose socioeconomic level is lower. It can also be seen that the academic grit scores of the students with upper (K-S=.00, S-W=.00, p<.05), middle (K-S=.00, S-W=.00, p<.05), and lower (K-S=.00, S-W=.00, p<.05) socioeconomic levels do not exhibit a normal distribution. Therefore, Kruskal Wallis H Test was used to analyze whether the students' academic grit scores varied based on their socioeconomic levels. Table 13 shows the analysis results.

Table 13. Kruskal Wallis H test results for the students' academic grit scores based on their socioeconomic levels

Test	Socioeconomic Level	n	Rank Average	Df	H	p	r
Academic Grit	Upper	96	223.01	2	6.48	.04*	.13
	Middle	224	198.51				
	Lower	80	179.06				

*p<.05

Table 13 shows that the student's academic grit scores vary significantly based on their socioeconomic levels ($H_{(2)}$=6.48, p<.05). Std J-T Statistic value was found to be 2.52 according to the Jonckheere-Terpstra test. Therefore, the student's academic grit scores increase as the socioeconomic level increases, and the student's academic grit scores decrease as the socioeconomic level decreases. This difference is significant at .05 (J=20539.50, Z=2.52, p<.05, r=.13). The students' socioeconomic levels have a low effect on their academic grit.

As there is a significant difference between the groups, the Mann-Whitney U test was used to analyze which groups this difference stemmed from. Table 14 shows the analysis results.

Table 14. Mann Whitney U test results for the paired comparisons of the students' academic grit scores based on their socioeconomic levels

Test	Socioeconomic Level	n	Rank Average	Rank Sum	U	p	r
Academic Grit	Upper	96	174.01	16705.00	9455.00	.09	-
	Middle	224	154.71	34655.00			
	Upper	96	97.49	9359.50	2976.50	.01*	.19
	Lower	80	77.71	6216.50			
	Middle	224	156.30	35012.00	8108.00	.21	-
	Lower	80	141.85	11348.00			

*p<.05

According to Table 14, there is no significant relationship between the academic grit scores of the students from upper and middle socioeconomic levels (U=61.00, p>.05) and the academic grit scores of the students from middle and lower socioeconomic levels (U=8108.00, p>.05).

It was found that there is a significant difference between the academic grit scores of the students from upper and lowered socioeconomic levels (U=2976.50, p<.05, r=.19). The academic grit scores of the students from upper socioeconomic levels (median=43.50) are higher than those of students from lower socioeconomic levels (median=41.00). The effect size of this difference is small.

The changes in the student's academic grit scores based on the number of siblings were analyzed. For this purpose, the arithmetic average, standard deviation, and normality values of the students' academic grit skill scores based on the number of siblings (Kolmogorov-Smirnov/Shapiro-Wilk) were evaluated. Table 15 shows the descriptive statistics regarding the students' academic grit skill scores based on the number of siblings.

Table 15. Descriptive statistics of the students' academic grit based on the number of the siblings

Score	Number of Siblings	n	Mean	Std.Dev.	K-S/S-W
Academic Grit	1	137	40.46	8.77	.00/.00
	2	106	39.77	9.69	.00/.00
	3 and above	157	40.20	8.15	.00/.00

Table 15 shows the average ($\overline{X}$ =40.46) and standard deviation (S=8.77) of the academic grit scores of the students with 1 sibling; and the average ($\overline{X}$ =39.77) and standard deviation (S=9.69) of the academic grit scores of the students with 2 siblings, and the average ($\overline{X}$ =40.20) and standard deviation (S=8.15) of the academic grit scores of the students with 3 and more siblings. It can also be seen that the academic grit scores of the students with 1 sibling, 2 siblings, and 3 and more siblings do not exhibit normal distribution (K-S=.00, S-W=.00, p<.05). Therefore, whether the students' academic grit scores vary based on the number of siblings was analyzed using the Kruskal Wallis H test. Analysis results are shown in Table 16.

Table 16. Kruskal Wallis H test results for the students' academic grit scores based on the number of siblings

Test	Number of Siblings	n	Rank Average	Df	H	p
Academic Grit	1	137	205.57	2	.52	.77
	2	106	200.82			
	3 and above	157	195.86			

Table 16 shows that there is no significant difference in the student's academic grit scores based on the number of siblings ($H_{(2)}$=.52, p>.05).

The changes in the student's academic grit scores based on the status of pre-school education were analyzed. For this purpose, the arithmetic average, standard deviation, and normality values (Kolmogorov-Smirnov/Shapiro-Wilk) of the student's academic grit scores based on the status of pre-school education were evaluated. Table 17 shows the descriptive statistics of the academic grit scores based on the status of pre-school education.

Table 17. Descriptive Statistics of the Students' Academic Grit Scores Based on the Status of Pre-School Education

Score	Status of Pre-School Education	n	Mean	Std.Dev.	K-S/S-W
Academic Grit	Yes	275	40.84	8.69	.00/.00
	No	125	38.72	8.82	.00/.00

Table 17 shows the average ($\overline{X}$ =40.84) and standard deviation (S=8.69) of the academic grit scores for the students who received pre-school education; and the average ($\overline{X}$ =38.72) and standard deviation (S=8.82) of the academic grit scores for the students who did not receive pre-school education. In addition, it can be seen that the academic grit scores of the students who received pre-school education and those who did not receive pre-school education (K-S=.00, S-W=.00, p<.05) do not exhibit a normal distribution. Based on these results, whether the students' academic grit scores vary based on the status of pre-school education was analyzed using the Mann-Whitney U test, and the results were evaluated. Analysis results are shown in Table 18.

Table 18. Results of the Mann Whitney U test for the students' academic grit based on the status of pre-school education

Test	Status of Pre-School Education	n	Rank Average	Rank Sum	U	p	r
Academic Grit	Yes	184	211.21	58082.00	14243.00	.01*	.14
	No	216	176.94	22118.00			

*p<.05

Table 18 shows that the student's academic grit scores vary significantly based on the status of pre-school education (U=14243.00, Z=-2.751, p<.05, r=0.14). The academic grit scores of the students who received pre-school education (median=43.00, n=184) are higher than those of students who did not (median=41, n=216). The effect size calculated for this data is low.

DISCUSSION, CONCLUSION, and SUGGESTIONS

Findings demonstrate that the academic grit skills and the academic success of the fourth-grade students involved in the study are high. Literature (Postigo et al., 2021; Cosgrove, Chen, & Castelli, 2018; Tucker-Drob et al., 2016; Dixson et al., 2016; Guerrero et al., 2016; West et al., 2016; Ivcevic & Brackett, 2014; Duckworth & Quinn, 2009) shows that the academic grit level is higher in lower age groups. Studies carried out with samples that include the age groups between 10 and 18 show that grit can be an important factor in anticipating adolescents' academic success. There is a positive, mid-level relationship between the academic grit skill scores and academic success scores of fourth-grade students. It was presented that 9% of the total variance of students' academic grit skills stems from their academic success. The remaining variance of 91% stems from other variables. A review of the studies on grit and academic success shows that there is a positive relationship between academic grit and academic success for primary school students (Jiang et al., 2019), secondary school students (Clark & Malecki, 2019; Dumfart & Neubauer, 2016; Guerrero et al., 2016; Dudovitz, Chung, Dosanjh, & Wong, 2016), high school students (Credé et al., 2017; Dixson, 2019) and undergraduate students (Reraki, Celik, & Sariçam, 2015; Wolter & Hussain, 2015; Kelly, Matthews, & Bartone, 2014; Robertson-Kraft & Duckworth, 2014). Xu e al. (2021) determined that there is a positive relationship between grit and academic success for East Asian and British students. In their study on agriculture trainers, Rogers, Townsend, and Lindner (2004) presented that there is a significant relationship between academic grit and the academic success of agriculture trainers. Rojas and Usher (2012) determined a significant relationship between grit and success in mathematics lessons in their studies on primary and secondary school students.

Lam and Zhou (2019) analyzed the studies that examined the relationship between grit and academic success. They found a positive and significant relationship between grit and academic success in most of the studies. Serin (2021b) also found that students with higher report card grades have higher academic grit than others. It may demonstrate that students who display academic achievement are more determined than others. The literature stated that other factorsmight be instrumental in explaining the relationship between academic grit and educational outcomes (Flanagan & Einarson, 2017; Lee & Sohn, 2017; Tucker-Drob et al., 2016).

It was determined that the academic grit of primary school students varies significantly based on gender. Female students' academic grit levels are higher than male students. It may stem from the fact that the tendency for success is higher for female students. Literature includes studies that obtain similar and different findings. Therefore, it can be stated that gender affects academic grit skills. Studies conducted on the subject show that the academic grit levels of female students are significantly higher than that of male students (Sagkal et al., 2020; Clark & Malecki, 2019; Oriol, Miranda, Oyanedel, & Torres, 2017; Christensen & Knezek, 2014; Eskreis-Winkler, Shulman, Beal, & Duckworth, 2014). Similar to the findings obtained from the literature, Rojas and Usher (2012) found in their study on fourth-grade and eighth-grade students that grit is affected by gender in favor of female students.

Similarly, Soysal Işıkçı (2022) found in his study that the academic perseverance of female students is higher than that of males. In studies carried out on postgraduate students by Suhruth and Deb (2017), on Ph.D. students by Cross (2014), and undergraduate students by (Kannangara et al. (2018), it was concluded that female students have higher grit. While Serin (2021b) found in the study of 10-11-12th-grade students and Eryiğit (2022) in her study with third-grade students, and Whipple and Dimitrove-Grajzl (2020) found in their studies that gender has a predicting role in concerning grit, it was determined that this effect was in favor of male students unlike in other studies. Unlike these

findings, in their study on agriculture trainers, Eryiğit (2022), in her study with fourth-grade students, and Rogers, Townsend, and Lindner (2004) determined that the academic grit skills of the agriculture trainers were high and that academic grit did not significantly vary based on gender. Similarly, in studies by Duckworth and Quinn (2009) on students between the ages of 11 and 17, in the study by Gumus (2021) and Gorman (2015) on high school students, in the studies by Rusadi et al. (2021) and Porter (2019) on undergraduate students and in the study by Serin (2021a) on fourth-grade students, it was determined that gender does not affect grit.

It was also seen that the student's academic grit skill scores did not significantly vary based on the mother's educational status. Therefore, it was determined that the mother's educational status did not affectacademic grit skills. As literature is limited in research on academic grit, some examples were given about studies carried out on the variable of academic success concerning academic grit. In studies carried out by Acar (2021) on secondary school students and by Gumus (2021) on high school students, it was seen that academic grit did not vary based on the mother's educational status. Ates (2008) determined that the mother's educational status did not affect the academic success of secondary school students.

Although academic grit scores do not significantly vary based on the mother's educational status according to the results, it can also be stated that as the mother's educational status increases, average academic grit scores also increase. Establishing that the educational status of the mother affects academic success, Guven (2019) found a significant difference between the rate of mothers with lower educational levels who have children with high academic success and mothers with higher educational levels who have children with high academic success. Kotaman (2008) also found a positive, significant relationship between academic success and the mother's educational status. Raty (2006) stated that the mother's educational level differences influence the children's participation in education and academic success. These findings suggest that mothers with a high level of education are more aware in terms of education, and due to this awareness, they guide their children in a way that improves their academic success.

Akkas's (2011) study on eighth-grade students and Yilmaz's (2017) on secondary school students, which differ from the research results, determined that students' academic success varies based on the mother's educational status. Moreover, Ural and Cinar (2014) determined in their studies on seventh-grade students that their academic success significantly varied based on the MES. Finally, Porter (2019) found that the academic grit of undergraduate students significantly varies based on the MES and that academic grit increases in parallel with the MES.

It was determined that the academic grit of primary school students significantly varies based on the FES. The academic grit level of students whose fathers received education at the undergraduate level and above is higher than that of students whose fathers received education at other levels. It may stem from the fact that the father's support for autonomy increases in parallel with the level of educational status. Students who are supported better adapt to school, and accordingly, their level of success increases. Some studies in the literature display similarities with the findings of this study. By determining that the educational status of the father affects academic success, Guven (2019) found a significant difference between the likelihood of a father with a lower education level having a child with higher academic success and the likelihood of a father with a higher education level having a child with higher academic success. Kotaman (2008) also found a positive, significant relationship between the father's educational status and academic success. Raty (2006) determined that father's education level differences affect their children's participation in education and academic success. These findings suggest that fathers with a higher level of education are more aware in terms of education. Due to this awareness, they guide their children in a way that improves their academic success. Porter (2019) also found in a study on undergraduate students that academic grit significantly varied based on the father's educational status and that as the father's level of education increased, so did the child's academic grit. In studies by Akkas (2011) and Karaca (2020) on eighth-grade students and in studies by Karadayi Atalar (2019) on sixth-grade students, it was determined that academic

success significantly varied based on the educational status of the father. On the contrary, in studies by Gumus (2021) on high school students and by Acar (2021) on secondary school students, found that the FES did not affect academic grit.

The academic grit level of students included in the study increases in parallel with their socioeconomic level. It may stem from parents providing more reinforcement or offering a more prosperous learning environment when students' academic grit leads to success or when they come up with more straightforward and quicker solutions for problems. Other studies display similarities with these findings. It was determined that academic success increases in parallel with the family's socioeconomic level, level of income, and social capital for secondary school students (Saglik, 2012), primary and secondary school students (Guven, 2019), all students (Sirin, 2005), primary school students (Symeou, 2008) and fifth-grade students (Aktan, 2012). Contrary to these studies, it was determined by Borton and Grelle (2012) for secondary school students and Porter (2019) for undergraduate students that those with a lower socioeconomic level had higher academic grit. In addition, it was seen in a study carried out with eighth-grade students that there is a relationship between average grades and grit for students with a lower level of income (Guerrero et al., 2016).

Academic grit levels did not vary based on the number of siblings for the students included in the research. Albeit insignificant, the fact that academic grit scores increase as the number of siblings decreases may suggest that they become more involved in decision-making processes within the family. Academic grit level is also expected to increase since they would try to act more individually in the process of coping with their problems. Serin's (2021b) findings suggest a decrease in academic grit level as the number of siblings increases, which shows similarities to the study's findings. Unlike these findings, Gumus (2021) determined in research carried out on high school students that academic success increases as the number of siblings increases. Ekmekyermezoglu (2010) found that academic success significantly varies based on the number of siblings in favor of two siblings.

It was observed that the academic perseverance levels of the students in the study changed in favor of pre-school areas according to their pre-school education status. Pre-school education also increases internal motivation. Moreover, considering that out-of-school activities are implemented more at play age, it can be stated that children who grow up in this environment would improve themselves more and quicker in terms of the scope of grit. There are studies in the literature that show similarities with these findings. Aktan (2012) found that receiving pre-school education affects academic success for fifth-grade students. It was also found by Ergun (2003) for primary school students and by Turkkas, Anasiz, Ekinci, and Anasiz (2018) for eighth-grade students that those who received pre-school education have higher academic success. Hazarika and Viren (2013) stated that pre-school education improves academic performance according to their study on students between the ages of 7 and 18.

Suggestions

In line with the results, primary school teachers can be advised to implement activities (aiming to create environments suitable for improving academic grit) to help students gain academic grit to improve their academic success. Researchers may examine the relationship between primary school students' academic grit levels with various variables (psychological well-being, belief in self-sufficiency, motivation, psychological endurance, and competency in career development). Regression models may be created where variables associated with academic level grit level (predictiveness, intermediacy) can be examined together. In addition, it may be considered to carry out experimental studies that aim to increase the academic grit level in younger ages and design projects that would set an example for teachers or teacher candidates.

Ethics and Conflict of Interest

Before the applications were carried out, the participants were informed about the research's purpose and scope, and it was declared that there was no ethical violation. Therefore, the ethical committee approval was obtained for this research from On Dokuz Mayıs University Scientific Research Ethics Committee with the decision numbered 2020/372 dated June 23, 2020. The authors declared no

potential conflicts of interest with respect to the research, authorship, and/or publication of this article. This study is the extended version of the paper that was orally presented in the 19th International Primary Teacher Education Symposium 12-14 November 2021 (IPTES 2021).

Limitations

The study sample was limited to fourth-grade primary school students studying in Sivas and a sample of 400 people.

REFERENCES

Abay, A. R., & Keleşoğlu, F. (2016). Okul sosyal hizmeti perspektifinden lise öğrencilerinin akademik başarı düzeylerinin farklı değişkenler açısından incelenmesi [Investigate the levels of academic achievement of high school students in terms of some variables from the perspective school social work]. *Yalova Journal of Social Sciences, 6*(11), 9-25. https://doi.org/10.17828/yalovasosbil.286917

Acar, B. (2021). *Ortaokul öğrencilerinin akademik azimleri ile benlik saygısı ve denetim odağı arasındaki ilişkinin incelenmesi* [The Relationship between university students level of self-esteem and their academic achievement] (Unpublished Master's thesis). İnönü University, Turkey.

Akkaş, M. (2011). *İlköğretim 8. sınıf öğrencilerinin ders başarılarını etkileyen kişisel sosyo-ekonomik ve okul kaynaklı faktörlerin incelenmesi (Konya ili Akşemseddin İ. O. örneği)* [Studying the personel and the social-ekonomical characteristics of students and school based factors that effects the succes of 8th grade of primary education school (Akşemseddin primary school in Konya] (Unpublished Master's thesis). Selçuk University, Turkey.

Akos, P., & Kretchmar, J. (2017). Investigating grit at a non-cognitive predictor of college success. *The Review of Higher Education, 40*(2), 163–186. https://doi.org/10.1353/rhe.2017.0000

Aktan, S. (2012). *Öğrencilerin akademik başarısı, öz düzenleme becerisi, motivasyonu ve öğretmenlerin öğretim stilleri arasındaki ilişki* [Relationship between the academic success, self-regulating learning skills, and motivations of 5th grade students and teaching styles of teachers] (Unpublished Doctoral dissertation). Balıkesir University, Turkey.

Akyüz, Y. (2012). *Türk eğitim tarihi* [History of Turkish education]. (30. Baskı). Ankara: Pegem Academy Publishing.

Alhadabi, A., Aldhafri, S., Alkharusi, H., Al-Harthy, I., AlBarashdi, H., & Alrajhi, M. (2019). Psychometric assessment and cross-cultural adaptation of the grit-s scale among omani and american universities' students. *European Journal of Educational Research, 8*(4), 1175-1191. https://doi.org/10.12973/eu-jer.8.4.1175

Allen, R. E., Kannangara, C., & Carson, J. (2021). True grit: How important is the concept of grit for education? A narrative literature review. *International Journal of Educational Psychology, 10*(1), 73-87. https://doi.org/10.17583/ijep.2021.4578

Al-Mutawah, M. A., & Fateel, M. J. (2018). Students' achievement in math and science: How grit and attitudes influence?. *International Education Studies, 11*(2), 97-105. https://doi.org/10.5539/ies.v11n2p97

Arslan, S., Akın, A., & Çitemel, N. (2013). The predictive role of grit on metacognition in Turkish university students. *Studia Psychologica, 55*(4), 311-320. https://doi.org/10.21909/sp.2013.04.645

Ateş, M. (2008). *İlköğretim ikinci kademe öğrencilerinin okuduğunu anlama düzeyleri ile Türkçe dersine karşı tutumları ve akademik başarıları arasındaki ilişki* [The relations between reading abilities of students at the second stage of primary school and their attitudes to turkish lesson and their academic achievement were studied] (Unpublished Doctoral dissertation). Selcuk University, Turkey.

Bazelais, P., Lemay, D. J., & Doleck, T. (2016). How Does grit ımpact college students' academic achievement in science?. *European Journal of Science and Mathematics Education, 4*(1), 33-43.

Borton, W., & Grelle, J. (2013). The dirt on grit: Examining relations with school adjustment, school performance, and theories of intelligence. Hanover College. Ditemu kembali dari http://psych. hanover. edu/research/Thesis12/papers/Borton% 20Grelle% 20IS% 20Final. pdf.

Bozgün, K., & Başgül, M. (2018). Akademik azim ölçeğinin Türkçeye uyarlanması: Geçerlik ve güvenirlik çalışması [Adaptation of academic grit scale to Turkish: validity and reliability study]. *Journal of Academic Social Science, 85*(6), 435-445. http://dx.doi.org/10.16992/ASOS.14521

Büyüköztürk, Ş., Çakmak, K. E., Akgün, Ö. E., Karadeniz, Ş., & Demirel, F. (2014). *Bilimsel araştırma yöntemleri* [Scientific research methods]. (16th edition). Ankara: Pegem Academy Publishing.

Christensen, R., & Knezek, G. (2014). Comparative measures of grit, tenacity and perseverance. *International Journal of Learning, Teaching and Educational Research, 8*(1), 16-30.

Christopoulou, M., Lakioti, A., Pezirkianidis, C., Karakasidou, E., & Stalikas, A. (2018). The role of grit in education: A systematic review. *Psychology, 9*, 2951-2971. https://doi.org/10.4236/psych.2018.915171

Clark, K. N., & Malecki, C. K. (2019). Academic Grit Scale: Psychometric properties and associations with achievement and life satisfaction. *Journal of school psychology, 72*, 49-66. https://doi.org/10.1016/j.jsp.2018.12.001

Cohen R. M. (2015). Teaching character: Grit, privilege, and America's obsession with novelty. *American Prospect.* Retrieved from http://prospect.org/article/can-grit-save-american-education

Cosgrove, J. M., Chen, Y. T., & Castelli, D. M. (2018). Physical fitness, grit, school attendance, and academic performance among adolescents. *BioMed Research International*, 1–7. https://doi.org/10.1155/2018/9801258

Costa, A., & Faria, L. (2018). Implicit theories of intelligence and academic achievement: A meta-analytic review. *Frontiers in Psychology, 9*, 829. https://doi.org/10.3389/fpsyg.2018.00829

Credé, M., Tynan, M. C., & Harms, P. D. (2017). Much ado about grit: A meta-analytic synthesis of the grit literature. *Journal of Personality and Social Psychology, 113*(3), 492-511. https://doi.org/10.1037/pspp0000102

Creswell, J. W. (2012). *Educational research: planning, conducting, and evaluating quantitative and qualitative research* (4. Edition). USA: Pearson Education Inc.

Cross, T. M. (2014). The gritty: grit and non-traditional doctoral student success. *Journal of Educators Online, 11*(3), 1-30.

Datu, J. A. D., Yuen, M., & Chen, G. (2017). Development and validation of the triarchic model of grit scale (tmgs): evidence from filipino undergraduate students. *Personality and Individual Differences, 114*, 198-205. https://dx.doi.org/10.1016/j.paid.2017.04.012

Dixson, D. D. (2019). Is grit worth the investment? How grit compares to other psychosocial factors in predicting achievement. *Current Psychology*, 1-8. https://doi.org/10.1007/s12144-019-00246-5

Dixson, D. D., Worrell, F. C., Olszewski-Kubilius, P., & Subotnik, R. F. (2016). Beyond perceived ability: The contribution of psychosocial factors to academic performance. *Annals of the New York Academy of Sciences, 1377*, 67–77. https://doi.org/10.1111/nyas.13210

Duckworth, A. L., Peterson, C., Matthews, M. D., & Kelly, D. R. (2007). Grit: perseverance and passion for long-term goals. *Journal of personality and social psychology, 92*(6), 1087. https://doi.org/10.1037/0022-3514.92.6.1087

Duckworth, A. L., & Quinn, P. D. (2009). Development and validation of the Short Grit Scale (GRIT–S). *Journal of personality assessment, 91*(2), 166-174. https://doi.org/10.1080/00223890802634290

Dumfart, B., & Neubauer, A. C. (2016). Conscientiousness is the most powerful noncognitive predictor of school achievement in adolescents. *Journal of Individual Differences, 37*, 8–15. https://doi.org/10.1027/1614-0001/a000182

Ekmekyermezoğlu, N. (2010). *İlköğretim sekizinci sınıf öğrencilerinin İngilizce dersindeki akademik başarı durumlarına etki eden sosyo-kültürel faktörler* [Socio-cultural factors effecting academic successes of 8th grade students of primary education at English class] (Unpublished Master's thesis). İnönü University, Turkey.

Ergün, S. (2003). *Okul öncesi eğitim alan ve almayan ilköğretim birinci sınıf öğrencilerinin matematik yetenek ve başarılarının karşılaştırmalı olarak incelenmesi* [Comparison of mathematical successes and ability of the first year students who studied in kindergartens in primary school to those who didn't] (Unpublished Master's thesis). Marmara University, Turkey.

Eryiğit, K. (2022). *Pandemi sürecinde ilkokul öğrencilerinin teknoloji tutumları ve akademik azimlerinin matematik başarılarına etkisi* [The effect of primary school students' technology attitudes and academic perseverance on mathematics achievement during the pandemic process] (Unpublished Master's thesis). Niğde Ömer Halis University, Turkey.

Eskreis-Winkler, L., Shulman, E. P., Beal, S. A., & Duckworth, A. L. (2014). The grit effect: Predicting retention in the military, the workplace, school and marriage. *Frontiers in Psychology, 5*(36), 1-12. https://doi.org/10.3389/fpsyg.2014.00036

Flanagan, K. M., & Einarson, J. (2017). Gender, Math Confidence, and Grit: Relationships with Quantitative Skills and Performance in an Undergraduate Biology Course. CBE—Life Sciences Education, 16, ar47. https://doi.org/10.1187/cbe.16-08-0253

Fraenkel, J. R., Wallen, N. E., & Hyun, H. H. (2012). *How to design and evaluate research in education.* USA: McGraw-Hill Companies Inc.

Gorman, R. (2015). *An examination of academic grit in urban high schools* (Unpublished Doctoral dissertation). Retrieved from ProQuest Dissertations and Theses database. (UMI No. 10029744). Educational Leadership, Research, and Technology, Western Michigan University.

Guerrero, L. R., Dudovitz, R., Chung, P. J., Dosanjh, K. K., & Wong, M. D. (2016). Grit: A potential protective factor against substance use and other risk behaviors among Latino adolescents. *Academic Pediatrics, 16*, 275–281. https://doi.org/10.1016/j.acap.2015.12.016

Gümüş, B. (2021). *Lise öğrencilerinin covid-19 döneminde stresle başaçıkma düzeyleri ve azimleri arasındaki ilişkinin incelenmesi* [Managing stress of high school students in the Covid-19 period investigation of the relationship between their levels and their attitude] (Unpublished Master's thesis), Hasan Kalyoncu University, Turkey.

Güven, P. (2019). *İlkokul ve ortaokul öğrencilerinin akademik başarılarının yordanmasında ana babanın akademik başarıya ilişkin beklentisi ve eğitime katılımının rolü* [The role of parents' expectation of success and parental involvement in prediction of primary and secondary school students' academic success] (Unpublished Master's thesis), Kastamonu University, Turkey.

Hazarika, G., & Viren, V. (2013). The effect of early childhood developmental program attendance on future school enrollment in rural North India. *Economics of Education Review, 34*(1), 146-161. https://doi.org/10.1016/j.econedurev.2013.02.005

Hinojosa, Y., Lu, M. T. P., & Vela, J. C. (2019). Exploring positive psychology, cultural, and family predictors of latina/o students' psychological grit. *Journal of Multidisciplinary Graduate Research, 3*(1), 48-61.

Hodge, B., Wright, B., & Bennett, P. (2017). The Role of Grit in Determining Engagement and Academic Outcomes for University Students. *Research in Higher Education, 59*, 448-460. https://doi.org/10.1007/s11162-017-9474-y

Hwang, M. H., Lim, H. J., & Ha, H. S. (2017). Effects of grit on the academic success of adult female students at Korean Open University. *Psychological Reports, 121*, 705-725. https://doi.org/10.1177/0033294117734834

Ivcevic, Z., & Brackett, M. (2014). Predicting school success: Comparing conscientiousness, grit, and emotion regulation ability. *Journal of Research in Personality, 52*, 29-36. https://doi.org/10.1016/j.jrp.2014.06.055

Jeynes, W. H. (2011). *Parental involvement and academic success.* (1st Edition). Routledge. https://doi.org/10.4324/9780203843444

Jiang, W., Xiao, Z., Liu, Y., Guo, K., Jiang, J., & Du, X. (2019). Reciprocal relations between grit and academic achievement: A longitudinal study. *Learning and Individual Differences, 71*, 13-22. https://doi.org/10.1016/j.lindif.2019.02.004

Kannangara, C. S., Allen, R. E., Waugh, G., Nahar, N., Khan, S. Z. N., Rogerson, S., & Carson, J. (2018). All that glitters is not grit: Three studies of grit in university students. *Frontiers in Psychology, 9*, 15-39. https://doi.org/10.3389/fpsyg.2018.01539

Karaca, Ü. (2020). *Ortaokul 8. sınıf öğrencilerinin İngilizce dersindeki akademik başarı düzeyleri ile sosyal çevre koşulları arasındaki ilişki* [The relationship between the social environmental conditions and the academic success levels of the 8th grade secondary school students in English class] (Unpublished Master's thesis), Ankara University, Turkey.

Karadayı Atalar, Ü. B. (2019). *Ortaokul 6. sınıf öğrencilerinin okuduğunu anlama becerisi ile akademik başarısı arasındaki ilişki* [The relation between 6th grade secondary school students' reading skills and their academic success], (Unpublished Master's thesis), Amasya University, Turkey.

Kaya, S., & Karakoc, D. (2022). Math mindsets and academic grit: How are they related to primary math achievement?. *European Journal of Science and Mathematics Education, 10*(3), 298-309. https://doi.org/10.30935/scimath/11881

Kelly, D. R., Matthews, M. D., & Bartone, P. T. (2014). Grit and hardiness as predictors of performance among West Point cadets. *Military Psychology, 26*, 327–342. https://doi.org/10.1037/mil00000050

Kleiman, E. M., Adams, L. M., Kashdan, T. B., & Riskind, J. H. (2013). Gratitude and grit indirectly reduce risk of suicidal ideations by enhancing meaning in life: Evidence for a mediated moderation model. *Journal of Research in Personality, 47*(5), 539-546. https://doi.org/10.1016/j.jrp.2013.04.007

Kotaman, H. (2008). Türk ana babalarının çocuklarının eğitim öğretimlerine katılım düzeyleri [Turkish parents' participation levels in their children's education]. *Journal of Uludag University Faculty of Education, 21*(1) , 135-149.

Lam, K. K. L., & Zhou, M. (2019). Examining the relationship between grit and academic achievement within K-12 and higher education: A systematic review. *Psychology in the Schools, 56*(10), 1654-1686. https://doi.org/10.1002/pits.22302

Lee, S., & Sohn, Y. W. (2017). Effects of grit on academic achievement and career-related attitudes of college students in Korea. *Social Behavior and Personality: An International Journal, 45*, 1629-1642. https://doi.org/10.2224/sbp.6400

Lou, N. M., & Noels, K. A. (2019). Promoting growth in foreign and second language education: A research agenda for mindsets in language learning and teaching. *System, 86*, 102126. https://doi.org/10.1016/j.system.2019.102126

Meyer, G., Shatto, B., Kuljeerung, O., Nuccio, L., Bergen, A., & Wilson, C. R. (2020). Exploring the relationship between resilience and grit among nursing students: a correlational research study. *Nurse education today*, *84*, 104246, 1-5. https://doi.org/10.1016/j.nedt.2019.104246

Mohan, V., & Kaur, J. (2021). Assessing the relationship between grit and academic resilience among students. *Issues and Ideas in Education*, *9*(1), 39-47. https://doi.org/10.15415/iie.2021.91005

Oriol, X., Miranda, R., Oyanedel, J. C., & Torres, J. (2017). The role of self-control and grit in domains of school success in students of primary and secondary school. *Frontiers in Psychology*, *8*(1716), 1-8. https://doi.org/10.3389/fpsyg.2017.01716

Özhan, M. B., & Boyacı, M. (2018). Üniversite öğrencilerinde depresyon, anksiyete ve stresin yordayıcısı olarak azim: Bir yapısal eşitlik modellemesi [Grit as a predictor of depression, anxiety and stress among university students: a structural equation modeling]. *Anatolian Journal of Psychiatry*, *19*(4), 370-376. https://doi.org/10.5455/apd.285042

Perez, M. (2015). Obtaining academic success: Nurturing grit in students. *Journal of Interpersonal Relation, Intergroup Relations and Identity*, *8*, 56-63.

Porter, M. (2019). *The development and validatıon of a vignette-based academic grit scale* (Unpublished Doctoral dissertation). The University of Alabama, Tuscaloosa, Alabama. (Order No. 13810607). Available from ProQuest Dissertations & Theses Global. (2241697086). Retrieved from https://www.proquest.com/dissertations-theses/development-validation-vignette-based academic/docview/2241697086/se-2?accountid=16701

Postigo, A., Cuesta, M., Fernández-Alonso, R., García-Cueto, E., & Mu˜niz, J. (2021). La tenacidad académica modula la evolución del rendimiento escolar: Unanálisis de transiciones latentes. *Revista de Psicodidáctica*, *26*, 87–95. https://doi.org/10.1016/j.psicod.2021.02.002

Raty, H. (2006). What comes after compulsory education? A follow-up study on parental expectations of their child's future education. *Educational Studies*, *32*(1), 1-16. https://doi.org/10.1080/03055690500415837

Reraki, M., Çelik, İ., & Sarıçam, H. (2015). Grit as a mediator of the relationship between motivation and academic achievement. *Ozean Journal of Social Science*, *8*(1), 19-32.

Rimfeld, K., Kovas, Y., Dale, P. S., & Plomin, R. (2016). True grit and genetics: Predict-ing academic achievement from personality. *Journal of Personality and Social Psy-chology*, *111*, 780-789. https://doi.org/10.1037/pspp0000089

Rivkin, S. G., Hanushek, E. A., & Kain, J. F. (2005). Teachers, schools, and academic achievement. *Econometrica*, *73*(2), 417-458. https://doi.org/10.1111/j.1468-0262.2005.00584.x

Robertson-Kraft, C., & Duckworth, A. L. (2014). True grit: Trait-level perseverance and passion for long-term goals predicts effectiveness and retention among novice teachers. *Teachers College Record*, *116*(3), 1–27. https://doi.org/10.1177/016146811411600306

Rojas, J. P., Reser, J. A., Usher, E. L., & Toland, M. D. (2012). *Psychometric properties of the Academic Grit Scale*. Lexington: University of Kentucky. Retrieved from http://sites.education.uky.edu/motivation/files/2013/08/RojasUsher.pdf

Rojas, J. P., & Usher, E. L. (2012). Exploring the correlations among creativity, grit, and mathematics achievement in socioeconomically diverse schools. Poster presented at the Graduate Student Conference for Children at Risk in Lexington, KY.

Rogers, J. F., Townsend, C. D., & Lindner, J. R. (2004). Perseverance of agricultural educators by academic attainment. *Journal of Agricultural Education*, *45*(1), 74-85. https://doi.org/10.5032/jae.2004.01074

Rusadi, R. M., Sugara, G. S., & Isti'adah, F. N. (2021). Effect of mindfulness-based cognitive therapy on academic grit among university student. *Current Psychology: A Journal for Diverse Perspectives on Diverse Psychological Issues*. Advance online publication. https://doi.org/10.1007/s12144-021-01795-4

Sağkal, A. S., Soylu, Y., Pamukçu, B., & Özdemir, Y. (2020). Akademik azim ölçeğinin (aaö) Türkçeye uyarlanması: Geçerlik ve güvenirlik çalışması [Turkish adaptation of the academic grit scale: a validity and reliability study]. *Mehmet Akif Ersoy University Journal of Education Faculty*, *1*(56), 326-344. https://doi.org/10.21764/maeuefd.613223

Sağlık, M. A. (2012). *İlköğretim öğrencilerinin teknoloji ve tasarım dersine yönelik tutumları ile akademik başarılarının incelenmesi* [The examination of the relation between the attitudes of the primary school students towards Technology an Design lesson and their academic success] (Unpublished Master's thesis). Akdeniz University, Turkey.

Serin, G. (2021a). *İlkokul 4. sınıf öğrencilerinin akademik azimleri ile öz düzenleme becerileri arasındaki ilişkinin incelenmesi* [Analysis of the relationship between the academic responsibilities and self organization skills of primary school 4th grade students] (Unpublished Master's thesis). Mersin University, Turkey.

Serin, M. S. (2021b). *Ergenlerde azim: birey, aile ve çevresel faktörlerin yordayıcılığının incelenmesi* [Preseverance in adolescents: the investigation of the predictive role of individual, family and environmental factors] (Unpublished Master's thesis). Erzincan Binali Yıldırım University, Turkey.

Soysal Işıkçı, D. (2022). Lise öğrencilerinin toplum 5.0 hakkındaki görüşlerinin analitik düşünme ve akademik azim bağlamında incelenmesi [Examination of high school students' views on society 5.0 in the context of analytical thinking and academic perseverance] (Unpublished Master's thesis). Necmettin Erbakan University, Turkey.

Strayhorn, T. L. (2014). What role does grit play in the academic success of black male collegians at predominantly White institutions? *Journal of African American Studies, 18*, 1-10. https://doi.org/10.1007/s12111-012-9243-0

Sturman, E. D., & Zappala-Piemme, K. (2017). Development of the grit scale for children and adults and its relation to student efficacy, test anxiety, and academic performance. *Learning and Individual Differences, 59*, 1-10. https://doi.org/10.1016/j.lindif.2017.08.004

Suhruth, A., & Deb, A. (2017). Flourishing among postgraduate student: The role of resilience, meaningfulness and grit. *Indian Journal of Community Psychology, 13*(1), 24-37.

Symeou, L. (2008). From school-family links to social capital: Urban and rural distinctions in teacher and parent networks in Cyprus. *Urban Education, 43*(6), 696-722. https://doi.org/10.1177/0042085907311825

Şirin, S. R. (2005). Socioeconomic status and academic achievement: A meta-analytic review of research. *Review of Educational Research, 75*(3), 417-453. https://doi.org/10.3102/00346543075003417

Tucker-Drob, E. M., Briley, D. A., Engelhardt, L. E., Mann, F. D., & Harden, K. P. (2016). Genetically-mediated associations between measures of childhood character and academic achievement. *Journal of Personality and Social Psychology*. https://doi.org/10.1037/pspp0000098

Türkkaş Anasız, B., Ekinci, C. E., & Anasız, B. Y. (2018). Okul öncesi eğitime katılımın daha sonraki yıllardaki akademik başarıya etkisi: TEOG sınavları [The impact of pre-primary education on students' academic achievement in later schooling years: TEOG exams]. *Inonu University Journal of the Faculty of Education, 19*(2), 154-173. https://doi.org/0.17679/inuefd.374051

Ural, A., & Çınar, F. N. (2014). Anne ve babanın eğitim düzeyinin öğrencinin matematik başarısına etkisi [The effect of parents' level of education on students' mathematics achievement]. *Mehmet Akif Ersoy University Journal of The Institute of Educational Sciences, 3*(4), 42-57.

Weisskirch, R. S. (2016). Grit, self-esteem, learning strategies and attitudes and esti-mated and achieved course grades among college students. *Current Psychology, 37*, 21-27. https://doi.org/10.1007/s12144-016-9485-4

West, M. R., Kraft, M. A., Finn, A. S., Martin, R. E., Duckworth, A. L., Gabrieli, C. F., & Gabrieli, J. D. (2016). Promise and paradox: Measuring students' non-cognitive skills and the impact of schooling. *Educational Evaluation and Policy Analysis, 38*, 148-170. https://doi.org/10.3102/0162373715597298

Whipple, S., & Dimitrove-Grajzl, V. (2021). Grit, fit, gender and academic achievement among first-year college students. *Psychology in the Schools, 58*(2), 332-350. https://doi.org/10.1002/pits.22449

Wolters, C. A., & Hussain, M. (2015). Investigating grit and its relations with college students' self-regulated learning and academic achievement. *Metacognition and Learning, 10*(3), 293-311. https://doi.org/10.1007/s11409-014-9128-9

Xu, K. M., Cunha-Harvey, A. R., King, R. B., de Koning, B. B., Paas, F., Baars, M., Zhang, J., & De Groot, R. (2021). A cross-cultural investigation on perseverance, self-regulated learning, motivation, and achievement. *Compare: A Journal of Comparative and International Education, 51*, 1-19. https://doi.org/10.1080/03057925.2021.1922270

Yılmaz, E. (2017). *Ortaokul öğrencilerinin akademik başarılarının yordanmasında umut ve yaşam doyumlarının incelenmesi* [Examination of hope and life satisfaction in predicting academic sucess of secondary school students] (Unpublished Master's thesis). Marmara University, Turkey.

IOJPE

ISSN: 1300 – 915X
www.iojpe.org

International Online Journal of Primary Education *2023, volume 12, issue 1*

AN INVESTIGATION OF STUDENTS' ORIENTEERING PROCESS AS TO THE STEPS OF POLYA'S PROBLEM-SOLVING METHOD

Fatma Gül UZUNER
Assist. Prof. Dr., Kafkas University, Dede Korkut Faculty of Education,
Primary Education Department, Kars, Turkey
ORCID: https://orcid.org/0000-0001-8483-6021
fgu61@hotmail.com

Durmuş EKİZ
Prof. Dr., Trabzon University, Fatih Faculty of Education,
Primary Education Department, Trabzon, Turkey
ORCID: https://orcid.org/0000-0002-0558-8144
dekiz@trabzon.edu.tr

Received: July 01, 2022 **Accepted:** November 20, 2022 **Published:** March 31, 2023

Suggested Citation:
Uzuner, F. G., & Ekiz, D. (2023). An investigation of students' orienteering process as to the steps of Polya's problem-solving method. *International Online Journal of Primary Education (IOJPE), 12*(1), 61-83. https://doi.org/10.55020/iojpe.1139460

Abstract

Orienteering is an enjoyable sporting activity, which is believed to contribute to its participants' problem-solving skills. People who are engaged in orienteering is expected to hold a map correctly, find their exact place on the map, read the map, make a plan and carry it out to reach the checkpoint, as well as checking the accuracy of the destination. Such steps to be followed during orienteering resemble those of Polya's problem-solving method in education. From this standpoint, this study focused on Polya's problem-solving steps in the field of mathematics, in relation to the outdoor sport of orienteering. On the whole, the present study aimed to examine fourth-grade students at primary school concerning their involvement in an orienteering process as to the steps of Polya's problem-solving method. A case study method was employed from among qualitative research approaches, and a program implementation was adopted as one of the sub-types of the case study method. In this context, the study sample was selected with the convenience sampling technique, from among the purposive sampling techniques. Observations, semi-structured interviews, and head cameras were used as data collection tools. The results indicated that the steps of Polya's problem-solving method can be used for problem-solving during the orienteering process. Based on the results, it is recommended that practical studies be conducted with similar or different research methods so as to contribute to the field.

Keywords: Orienteering, problem solving, primary school students, case study, mathematics.

INTRODUCTION

Orienteering is a sport that requires the use of a map and compass in unknown terrain and includes physical and mental challenges (Orienteering New Zealand, 2021). Having begun as a military exercise in Scandinavia at the end of the 19th century, orienteering became popular owing to a scout leader, Ernst Killander. To attract young people to athletics, Killander prepared courses requiring the use of a map and compass in the Swedish countryside. It is, therefore, regarded to have begun in Sweden and started to spread to other countries (Bektaş et al., 2019; Boga, 1997). Bjorn Kjellstrom, the Swedish inventor of the protractor-type compass, also introduced the sport of orienteering to the USA upon moving there in 1946 (August, 1975; Boga, 1997).

Orienteering can be considered as either a competitive outdoor sport or an entertaining activity. In this activity, the skills of map reading and using a compass are combined with a challenging physical activity (Campbell & Burton, 1996). Participants try to find control points on a land map in as short a time as possible (Cambridge Dictionary, 2021). Orienteering is, therefore, both a game (Celestino & Pereira, 2012; Kim, 2010) and a cross-country running art that stimulates interest in coordination between the brain and body (Boga, 1997; British Schools Orienteering Association [BSOA], 2015). Additionally, it can be considered in connection with adventure education (Bomgardner, 2014).

Orienteering is a form of navigation and requires map and compass skills (Cordes & Hutson, 2015). In this sense, participants must learn what a map is and orienteer with the aid of a map, and then learn how to use a compass, and finally, orienteer with the aid of the map and compass (Morisbak, 1982). Apart from map and compass skills, participants are supposed to be physically fit, mentally alert, and be able to make decisions while orienteering (Kiwi-O Manual, 2014). If participants act too fast and go in the wrong direction while orienteering, they are not likely to win. To win the competition, participants must move by solving the problems encountered on the course (Hugglestone & Howard, 1983). The direction that the participant is to take is not limited to the direction that the facilitator expects (Hodgson & Bailie, 2011). In a sense, orienteering is a thinking person's sport (Bektaş et al., 2019). It can exert a positive impact on the development of the brain and body (Deniz et al., 2011; Larkin & Grogger, 1975), and can contribute to an individual's all-round development (Celestino & Pereira, 2012; Kelly, 2014). It can, therefore, be suggested that orienteering is also a beneficial activity for children.

Contributing to the holistic development of individuals of all ages, orienteering is included in the curriculum in Türkiye and around the world (Bektaş et al., 2019). It can be made use of in physical education, mathematics, and geography curricula as well as an extra scholastic learning and adventure activity. Moreover, orienteering can enable interdisciplinary collaboration and function as a multi-faceted extracurricular activity resource (BSOA, 2015). It contributes to the development of many skills of individuals and can thus be considered as a student sport (Aksın, 2019).

Orienteering is believed to be an important learning resource (Di Tore et al., 2015). It enables the skills and understanding involved in teaching programs to be put into practice in a social context (Bradford, 1977; Kiwi-O Manual, 2014). Through orienteering, students can acquire knowledge of maps, contours, landforms, and land use concerning social studies/geography. It is also possible to argue that orienteering is of importance for physical education and health benefits since students are to walk, run and acquire agility in tracking through orienteering. Similar to the outcomes in mathematics, students may achieve with orienteering in subjects/skills such as planning, establishing spatial relationships, using scales, angles, symbols, time, distance, and speed, as well as thriving in arithmetic, measurement, and estimation. Regarding personal development, students can have the opportunity through orienteering to practice advanced planning, solve problems and make decisions, develop their memory and concentration skills, and increase their self-confidence and self-esteem (Kiwi-O Manual, 2014). Furthermore, students can also learn their strengths and weaknesses (Hammes, 2007) and improve their creativity and flexible thinking skills (Kim, 2010).

One of the skills that orienteering develops is the skill of problem solving (Bradford, 1977; Deniz et al., 2011). A problem is a special relationship that turns a task into a problem for a person. This relationship should involve an intellectual difficulty rather than a calculation (Schoenfeld, 1985). In other words, a problem can mean questions whose answers are not immediately certain (National Council of Teachers of Mathematics [NCTM], 2000). Problem solving is the process of solving a situation that requires a solution. During this process, by using their knowledge, skills, and understanding, people try to master a situation in which they have difficulty (Krulik & Rudnick, 1989; Posamentier & Krulik, 2016). The skill of problem solving is critical for all levels of education and is also one of the mathematical skills (Baykul, 2016).

Mathematical problem solving is the process of understanding how to solve a mathematics problem whose solution is unknown (Mayer & Hegarty, 1996). Problem solving is also a principal component of mathematics. A lack of problem-solving ability can limit the effect of mathematical knowledge, ideas, and skills (NCTM, 2000). The skills of mathematical thinking and of solving problems that are encountered in daily life should, therefore, be improved in children through problem-solving studies (Dinç-Artut & Tarım, 2009). Problems that are used in studies focusing on problem-solving in particular should also have certain characteristics such as being appropriate for children's cognitive level, being related to children's daily life, and stimulating their interest (Altun, 2008). In this context, good problems can set the stage for discovery and retention of mathematical ideas, and comprehension and implementation of mathematical features, patterns, and strategies, thereby prompting students to think.

These problems can be generated from students' environments or a mathematical context (NCTM, 2000). There might not be a formula for a solution to the problems generated, but the exact steps to solution can be developed (Altun, 2015). In this connection, Reys et al. (1998), for example, stated that G. Polya contributed a great deal to the process of problem solving. Lenchner (2005) also stated that Polya presented a four-step guide to successful problem solving.

Polya's problem-solving process consists of four steps, namely, understanding the problem, devising a plan, carrying out the plan, and looking back and checking. First of all, the problem should be understood by students. Following an understanding of the problem, a plan aimed at a solution to the relevant problem should be made, after which the plan should be carried out. Finally, the problem-solving process should be reviewed and evaluated (Polya, 1997). In this context, Polya considered heuristic strategies to be a tool in problem solving (Schoenfeld, 1985). Considering that orienteering can also develop problem-solving skills (Bradford, 1977; Deniz et al., 2011), it may be of great value to investigate whether or not there is a relationship between orienteering and the steps of problem-solving. Orienteering is reported to have positive impact on mental processes (Vaskan et al., 2019), thinking skills (Özal & Girgin, 2013; Pouya et al., 2017), attention and memory (Atakurt et al., 2017), problem-solving (Taş, 2010), and development of logical-mathematical intelligence (Özcan, 2007). Nevertheless, it is notable that Quenneville (1979) referred to orienteering as a tool to be used in mathematics teaching. Besides that, mathematical skills can be used during orienteering (Balkwill, 1996). Based on the results of such studies, it can be argued that orienteering may be used as an effective tool in education and the development of cognitive skills. However, there has not been much research on the reasons behind the effectiveness of orienteering in these processes. Not many different studies are present in the literature on why orienteering can be effective on problem-solving skills. Participants in orienteering events go through the same processes, repetitively, which are similar to Polya's problem-solving process. For this reason, the present study differs from those in the literature in this respect, and is believed to contribute to the literature with respect to problem-solving and orienteering. Finding a relationship between the mathematical problem-solving process and orienteering will contribute to both theory and practice. In other words, the existence of a relationship between an entertaining outdoor sport and the mathematical problem-solving process can contribute to the educational practices.

This study aimed to examine the orienteering process in primary school students according to Polya's steps of problem-solving. The stages of the orienteering process were revealed and evaluated according to the steps of Polya's problem-solving method. The relevant literature review has shown that no other study has ever discussed orienteering and Polya's problem-solving steps in the way presented in this study, which can offer a different understanding of why orienteering is an effective sport on problem-solving processes and how it can function as a tool in the education process. In this sense, it is considered that this study is important and its results will contribute to the field of orienteering and problem-solving in relation to theory and practice. From this standpoint, answers have been sought to the following research questions:

1. How is the orienteering process of primary school students investigated according to Polya's steps as a problem-solving method?
2. What are primary school students' feelings and thoughts about the orienteering process?

METHOD

This study employed the case study methodology, which is mostly included within the scope of qualitative research approaches. The case study method is a holistic research method. It uses multiple sources of evidence to evaluate or analyze a specific phenomenon or event (Anderson, 2005). Moreover, the case study makes it possible to discuss and examine a case thoroughly (Datta, 1990). In the present study, the orienteering process with primary school students was examined according to the steps of Polya's problem-solving method. Thus, a program implementation, which is one of the sub-types of the case study method, was taken as the basis (Datta, 1990).

Participants

A study sample was selected with the convenience sampling and maximum variation sampling methods, which are purposive sampling techniques. Within the scope of maximum variation sampling, utmost attention was paid to ensure that the study sample consisted of students with as many different characteristics as possible (Şimşek & Yıldırım, 2011). For that reason, students with different achievement levels and genders were selected in line with the purpose of this study. To achieve convenience sampling, it is essential to involve individuals who are convenient to reach in the research process (Ekiz, 2009). This study, therefore, involved a study sample being drawn from among a population with maximum diversity and easy access. Consequently, the sample study consisted of primary school students at fourth grade. Table 1 presents background information regarding the sample.

Table 1. Background information regarding the study sample

Student codes	Grade level	Gender	Academic grade point average in the subject of mathematics	Does the child enjoy solving mathematics problems?	Does the child enjoy games that involve running?	Does the child have any health problems to the extent that it prevents him/her from orienteering?
S1	4	Female	74	Yes	Yes	No
S2	4	Female	90	Yes	Yes	No
S3	4	Female	70	Yes	Yes	No
S4	4	Female	66	Yes	Yes	No
S5	4	Female	52	Partly	Yes	No
S6	4	Male	82	Yes	Yes	No
S7	4	Male	29	Partly	Yes	No

Note: For ethical reasons, participating students were given pseudonyms in the form of "Student 1 (S1)"

As can be seen in Table 1, the study sample consisted of seven participants, five of whom were girls and two boys, who all studied in the same class with a class size of seven students. The participants' average grade in the subject of mathematics was 66.14, but it was found that participants had different academic levels in the class. Two of the participants (S5, and S7) ended up enjoying solving mathematics problems only partly, while the other participants (S1, S2, S3, S4, and S6) enjoyed solving mathematics problems thoroughly. All participants reported that they enjoyed games involving running. Moreover, it appeared that participants had no prior knowledge related to orienteering and that none of them had any health problems that could prevent them from orienteering. Table 1 provides the relevant information given by teachers and students.

Instruments

The data collection tools were qualitative observations, semi-structured interview forms, and head cameras. Generally speaking, in qualitative observation, the researcher takes field notes based on the participants' activities and behaviors (Creswell, 2016a). In this study, the researcher took the required observation notes by making unstructured qualitative observations. The semi-structured interview is an open-ended process aimed at revealing participant views through a face-to-face or on the phone technique, including a series of questions (Creswell, 2016a). In this study, the semi-structured interviews were conducted by interviewing the participants face-to-face in order to reveal participants' feelings and thoughts while orienteering. For this purpose, the participants were asked what they thought about orienteering, and what feelings and thoughts they had while orienteering.

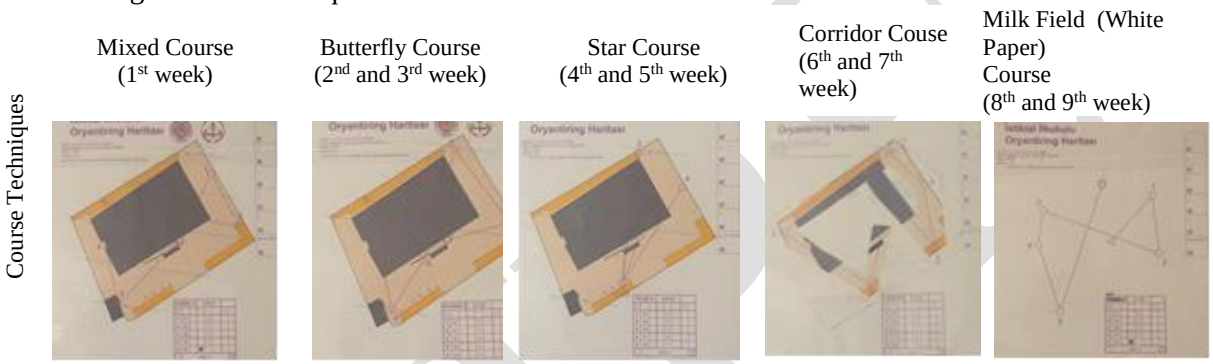
An additional study was conducted to monitor orienteering processes by having the students use head cameras. The field of view of the head camera was adjusted in such a way as to support the purpose of the study. Utilizing this field of view of the head camera made it possible to access data that would support the present study. With the aid of the head camera, participants' behaviors during the orienteering process could be examined in more detail, and detailed data were collected concerning how participants read the map, how they reached the checkpoints on the course, where they made mistakes

on the course, which problems they considered on the course, the length of time they spent thinking about the problems they encountered on the course, and the length of time it took them to complete the course. Therefore, first, the participants were fitted with head cameras, and were given their maps in turn. They then took their maps, went to the course and completed the course.

Data Collection Process

In this study, the participants' orienteering process was examined according to Polya's problem-solving steps. Accordingly, the data collection process was as follows:

1. The study sample was selected.
2. An orienteering map was drawn for the area where the orienteering was to take place.
3. While the course was being planned, a number of different orienteering course techniques were utilized, including: Mixed, butterfly, star, corridor, and white paper techniques. Figure 1 illustrated the images of the techniques used:



Mixed Course: This includes various orienteering activities (Karaca, 2008).
Butterfly Course: This consists of small courses with the same starting and ending points (Kelly, 2014)
Star Course: This is a course consisting of destinations that involve commuting to a center (Kelly, 2014).
Corridor Course: Destinations are found only according to the information about the corridor given on the map (Ferguson & Turbyfill, 2013).
Milk Field (White Paper): There is only course information on the map (Karaca, 2008).
Orienteering courses are planned from easy to difficult.
The type of each course can be seen on the relevant maps.

Figure 1. Maps of the orienteering techniques used

4. The participants were given the necessary preliminary information about orienteering.
5. The implementation took five weeks.
6. During the five weeks, nine exercises were performed.
7. The exercises were performed in the schoolyard.
8. During the exercises, observation was made by the researcher.
9. Data related to the orienteering process were collected with the head camera fitted to the students. The visuals of the materials used in the research are presented in Figure 2.
10. At the end of the procedure, semi-structured interviews were held with the students.

Image1. Orienteering map

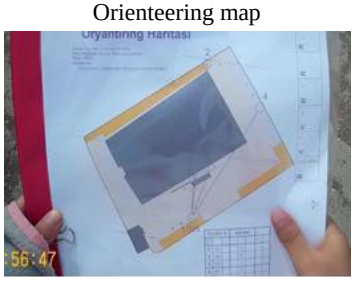


Image2. Control point (punch)

Image3. Head Camera

Figure 2. Images of the materials used in the study

Data Analysis

The data obtained using observation, semi-structured interviews, and head cameras were analyzed. While the data obtained from the observations and semi-structured interviews were subjected to descriptive analysis (Ekiz, 2009; Strauss & Corbin, 1990), those obtained from the head cameras were subjected to inductive content analysis (Patton, 2014). The data analysis results are presented in tables. Some encodings are used in tables. For instance, the expression "yes" indicates that the given action was fully performed, whereas the expression "no" indicates that the given action was not performed at all. The expression "partially" indicates that the given action was performed from time to time. In other words, it is used to indicate a point between yes and no.

In the descriptive analysis, analysis of data obtained from sources such as observations and interviews constituted the case, and a direct description of a situation formed the basis (Ekiz, 2009; Strauss & Corbin, 1990). During this process, through observations and semi-structured interviews within the framework of the steps outlined by Creswell (2016a; Creswell, 2016b), the raw data were collected, organized for analysis, read, coded manually, and converted into themes. In order to create the relevant themes, analysis was made based on the questions used in the interviews and the subjects discussed in the observations (Ekiz, 2007). Therefore, the participants were interviewed about the orienteering processes while the interviews were being recorded with a voice recorder. The interviews were then transcribed and read, and the codes (happiness, freedom, play puzzle, running game, etc.) were created and then combined under the theme of feelings and thoughts.

The data captured from the head cameras were subjected to inductive content analysis since there was an interaction between the researcher and the data, and exploration of the concepts by the researcher was the case (Patton, 2014). The images obtained from the head cameras were recorded in the form of behaviors. Such images were monitored without any template, coded, and converted into themes in this form. Here, coding was done by considering numerous behaviors ranging from the participants' holding of the map to their apparent way of thinking.

Regarding the quality (validity and reliability) of the qualitative data, triangulation was utilized and a long period was spent in the field (Creswell, 2016b; Merriam, 2015). In the study, triangulation was utilized by using observations, semi-structured interviews, and head cameras. In this regard, an attempt was made to answer the research questions with a deeper understanding by using the data obtained from semi-structured interviews, observations, and head cameras. The researcher made observations by spending time in the field and thereby, achieved a deeper understanding of the implementation process. In the end, the results were verified with two researchers and three data collection tools (Merriam & Tisdell, 2016).

RESULTS

Participants' Orienteering Process and Polya's Problem-Solving Steps

With the aid of the head cameras, data related to the participants' orienteering process were collected and analyzed, and certain findings were obtained. The tables (from Table 2 to Table 10) include the stages of "start, process and finish". These can be taken into consideration in terms of Polya's problem-solving process. The start means understanding the problem, the process means planning and implementation, and the finish denotes evaluation. Table 11 presents the findings that were reached through exploration. Under each table are explanations related to the findings. Table 2 presents the findings related to the first course.

As can be seen in Table 2, at the start of the first mixed orienteering course, some participants (S1, S3, and S6) were able to hold the map correctly, some participants (S2, S5, and S7) were partially able to hold it correctly, while one participant (S4) was not able to hold it correctly. While some of the participants (S1, S3, S5, and S6) went in the right direction at the start, the remaining participants were only partially able to go in the right direction. Some participants (S1, S3, S5, and S6) were able to go to the checkpoints on the map in the right order, while one participant (S7) partially followed the

checkpoint order and one participant (S2) could not follow the checkpoint order. Except for one of the participants (S2), the others were able to correctly punch the checkpoints given on the map.

Table 2. Findings related to mixed orienteering course-I.

	Participants	S1	S2	S3	S4	S5	S6	S7
Orienteering Process: Understanding, Planning, Implementation, Evaluation	*Start*							
	Did the participant hold the map correctly at the start?	Yes	Partially	Yes	No	Partially	Yes	Partially
	Did the participant go in the right direction at the start?	Yes	Partially	Yes	Partially	Yes	Yes	Yes
	Process							
	Did the participant go to the checkpoints given on the map in the right order?	Yes	No	Yes	No	Yes	Yes	Partially
	Did the participant correctly punch the checkpoints given on the map?	Yes	No	Yes	Yes	Yes	Yes	Yes
	Did the participant go to the wrong checkpoint?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	If so, how many times did he/she do that?	2	4	4	7	3	4	4
	What was the participant's main movement type on the course?	Walking	Running	Walking	Walking	Walking	Walking	Running
	What was the length of time for the participant's problem-solving on the course?	02 min 31 sec	01 min 29 sec	58 sec	13 sec	01 min 40 sec	01 min 06 sec	01 min 15 sec
	Did the participant adhere to the code of conduct on the course?	Yes	Yes	Yes	Partially (sometimes followed others)	Yes	Yes	Yes
	Finish							
	How long did it take the participant to complete the course?	07 min 07 sec	10 min 46 sec	05 min 09 sec	6 min 52 sec	08 min 53 sec	06 min 20 sec	08 min 21 sec

On the first course, all participants went to the wrong checkpoint at least twice, and the mean number of times that they went to the wrong checkpoint was 4. The main movement types of the participants on the course were walking (S1, S3, S4, S5, and S6) and running (S2, and S7). Moreover, the length of time for the participants' problem-solving on the course ranged between 13 sec and 02 min 31 sec, while that of the course completion ranged from 05 min 09 sec to 10 min 46 sec. One participant (S4) partially adhered to the code of conduct on the course, while the other participants adhered to that in full.

Findings related to the second course are shown in Table 3.

Table 3. Findings related to butterfly orienteering course-II

	Participants	S1	S2	S3	S4	S5	S6	S7
Orienteering Process: Understanding, Planning, Implementation, Evaluation	*Start*							
	Did the participant hold the map correctly at the start?	Yes	Yes	Partially	Partially	Yes	Partially	Partially
	Did the participant go in the right direction at the start?	Yes	Yes	No	Yes	Yes	No	No
	Process							
	Did the participant go to the checkpoints given on the map in the right order?	Partially	No	Yes	No	Yes	Yes	No
	Did the participant correctly punch the checkpoints given on the map?	Yes	Yes	Yes	No	Yes	Yes	Yes
	Did the participant go to the wrong checkpoint?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	If so, how many times did he/she do that?	2	1	8	7	5	6	8
	What was the participant's main movement type on the course?	Running	Walking	Running	Running	Running	Walking	Running
	What was the length of time for the participant's problem-solving on the course?	01 min	48 sec	11 sec	17 sec	40 sec	02 min 30 sec	27 sec
	Did the participant adhere to the code of conduct on the course?	Yes	Yes	Yes	Partially (sometimes followed others)	Yes	Yes	Yes
	Finish							
	How long did it take the participant to complete the course?	04 min 18 sec	04 min 28 sec	04 min 21 sec	05 min 01 sec	05 min 08 sec	08 min 09 sec	06 min 18 sec

As shown in Table 3, the findings related to the second course, i.e., butterfly orienteering, indicate that some participants (S1, S3, and S5) were able to hold the map correctly, while some participants (S3, S4, S6, and S7) were partially able to hold it correctly. Furthermore, while some of the participants (S1, S2, S4, and S5) went in the right direction at the start, the remaining participants were unable to go in the right direction. Some participants (S3, S5, and S6) were able to go to the checkpoints given on the map in the right order, while one participant (S1) partially followed the checkpoint order, and some participants (S2, S4, and S7) failed to follow it order at all. Except for one of the participants (S4), the others were able to correctly punch the checkpoints given on the map. On the second course, all participants went to the wrong checkpoint at least once, and the mean number of times that they went to the wrong checkpoint was 5.3. The main movement types of the participants on the course were walking (S2, and S6) and running (S1, S3, S4, S5, and S7). Moreover, the length of time for the participants' problem-solving on the course ranged between 11 sec and 02 min 30 sec, while that of the course completion times ranged from 04 min 18 sec to 08 min 09 sec. One participant (S4) partially adhered to the code of conduct on the course, while the other participants adhered to that in full.

Findings related to the third course are given in Table 4.

As is seen in Table 4, findings related to the third course, i.e., butterfly orienteering, indicate that, at the start, some participants (S1, S2, and S5) were able to hold the map correctly, while some participants (S3, S4, S6, and S7) were partially able to hold it correctly. While some of the participants (S1, S2, and S5) went in the right direction at the start, the remaining participants were unable to go in the right direction. Some participants (S1, S2, S5, and S6) were able to go to the checkpoints given on the map

in the right order, while some participants (S3, S4, and S7) found the checkpoints without following the checkpoint order.

Table 4. Findings related to butterfly orienteering course-III.

	Participants	S1	S2	S3	S4	S5	S6	S7
Orienteering Process: Understanding, Planning, Implementation, Evaluation	*Start*							
	Did the participant hold the map correctly at the start?	Yes	Yes	Partially	Partially	Yes	Partially	No
	Did the participant go in the right direction at the start?	Yes	Yes	No	No	Yes	No	No
	Process							
	Did the participant go to the checkpoints given on the map in the right order?	Yes	Yes	No	No	Yes	Yes	No
	Did the participant correctly punch the checkpoints given on the map?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Did the participant go to the wrong checkpoint?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	If so, how many times did he/she do that?	2	4	9	7	3	8	6
	What was the participant's main movement type on the course?	Walking	Walking	Running	Running	Running	Walking	Running
	What was the length of time for the participant's problem-solving on the course?	03 min 29 sec	57 sec	10 sec	12 sec	36 sec	03 min 02 sec	38 sec
	Did the participant adhere to the code of conduct on the course?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Finish							
	How long did it take the participant to complete the course?	05 min 47 sec	04 min 55 sec	06 min 24 sec	03 min 30 sec	04 min 37 sec	09 min 16 sec	05 min 20 sec

All of the participants were able to correctly punch the checkpoints. On the third course, all participants went to the wrong checkpoint at least twice, and the mean number of times that these participants went to the wrong checkpoint was 5.6. The main movement types of the participants on the course were walking (S1, S2, and S6) and running (S3, S4, S5, and S7). Moreover, the length of time for the participants' problem-solving on the course ranged between 12 sec and 03 min 29 sec, while that of the course completion ranged from 03 min 30 sec to 09 min 16 sec. All of the participants adhered to the code of conduct on the course.

Findings related to the fourth course can be seen in Table 5.

As evident in Table 5, findings related to the fourth course, i.e., star orienteering, indicate that, at the start, some participants (S1, S2, and S7) were able to hold the map correctly, some participants (S3, S5, and S6) were partially able to hold it correctly, while one participant (S4) failed to hold it correctly. While some of the participants (S1, S2, and S7) went in the right direction at the start, the remaining participants were unable to go in the right direction. Some participants (S1 and S5) were able to go to the checkpoint given on the map in the right order, some participants (S2, S3, and S6) partially followed it, and some participants (S4 and S7) tried to find the checkpoints without following the checkpoint order. All of the participants were able to correctly punch the checkpoints given on the map. On the fourth course, all participants went to the wrong checkpoint at least once, and the mean number of times that these participants went to the wrong checkpoint was 5.4.

Table 5. Findings related to star orienteering course-IV.

	Participants	S1	S2	S3	S4	S5	S6	S7
Orienteering Process: Understanding, Planning, Implementation, Evaluation	*Start*							
	Did the participant hold the map correctly at the start?	Yes	Yes	Partially	No	Partially	Partially	Yes
	Did the participant go in the right direction at the start?	Yes	Yes	No	No	No	No	Yes
	Process							
	Did the participant go to the checkpoints given on the map in the right order?	Yes	Partially	Partially	No	Yes	Partially	No
	Did the participant correctly punch the checkpoints given on the map?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Did the participant go to the wrong checkpoint?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	If so, how many times did he/she do that?	3	1	3	6	8	8	9
	What was the participant's main movement type on the course?	Running	Running	Running	Running	Running	Running	Walking
	What was the length of time for the participant's problem-solving on the course?	45 sec	50 sec	05 sec	15 sec	01 min 07 sec	46 sec	44 sec
	Did the participant adhere to the code of conduct on the course?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Finish							
	How long did it take the participant to complete the course?	04 min 48 sec	03 min 33 sec	01 min 24 sec	03 min 52 sec	05 min 45 sec	06 min 10 sec	07 min 09 sec

The main movement types of the participants on the course were walking (S7) and running (S1, S2, S3, S4, S5, and S6). Moreover, the length of time for the participants' problem-solving on the course ranged between 05 sec and 01 min 07 sec, while that of course completion ranged from 01 min 24 sec to 07 min 09 sec. All of the participants adhered to the code of conduct on the course.

Findings related to the fifth course are given in Table 6.

Table 6. Findings related to star orienteering course-V.

	Participants	S1	S2	S3	S4	S5	S6	S7
Orienteering Process: Understanding, Planning, Implementation, Evaluation	*Start*							
	Did the participant hold the map correctly at the start?	Yes	Yes	Partially	No	Partially	Yes	Yes
	Did the participant go in the right direction at the start?	Yes	Yes	Yes	No	No	Yes	Yes
	Process							
	Did the participant go to the checkpoints given on the map in the right order?	Partially	Partially	Partially	No	Yes	Yes	No
	Did the participant correctly punch the checkpoints given on the map?	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 6 (Continued). Findings related to star orienteering course-V.

Participants	S1	S2	S3	S4	S5	S6	S7
Did the participant go to the wrong checkpoint?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
If so, how many times did he/she do that?	2	1	6	8	3	3	9
What was the participant's main movement type on the course?	Running	Running	Running	Running	Running	Walking	Running
What was the length of time for the participant's problem-solving on the course?	17 sec	57 sec	13 sec	07 sec	35 sec	01 min 20 sec	42 sec
Did the participant adhere to the code of conduct on the course?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Finish							
How long did it take the participant to complete the course?	03 min 44 sec	02 min 31 sec	03 min 04 sec	03 min 22 sec	03 min 38 sec	05 min 38 sec	06 min 12 sec

As can be seen in Table 6, findings related to the fifth course, i.e., star orienteering show that, at the start, some participants (S1, S2, S6, and S7) were able to hold the map correctly, some participants (S3, S5) were partially able to hold it correctly, while one participant (S4) failed to hold it correctly. While some of the participants (S1, S2, S3, S6, and S7) went in the right direction at the start, the remaining participants were unable to go in the right direction. Some participants (S5 and S6) were able to go to the checkpoints given on the map in the right order and some participants (S1, S2, and S3) partially followed the checkpoint order, while some participants (S4 and S7) failed to follow the checkpoint order. All of the participants were able to correctly punch the checkpoints given on the map. On the fifth course, all participants went to the wrong checkpoint at least once, and the mean number of times that participants went to the wrong checkpoint was 4.6. The main movement types of the participants on the course were walking (S6) and running (S1, S2, S3, S4, S5, and S7). Moreover, the length of time for the participants' problem-solving on the course ranged between 07 sec and 01 min 20 sec, while that of the course completion ranged from 02 min 31 sec to 06 min 12 sec. All of the participants adhered to the code of conduct on the course.

Findings related to the sixth course are shown in Table 7.

As shown in Table 7, findings related to the sixth course, i.e., corridor orienteering indicate that, at the start, some participants (S1, S2, S6, and S7) were able to hold the map correctly, one participant (S5) was partially able to hold it correctly, while one participant (S4) failed to hold it correctly. While some of the participants (S1, S2, S5, S6, and S7) went in the right direction at the start, the remaining participants were only partially able to go in the right direction. Some participants (S1, S5, and S6) were able to go to the checkpoints on the map in the right order, while one participant (S2) partially followed the checkpoint order and some participants (S3, S4, and S7) did not follow the checkpoint order. All of the participants were able to correctly punch the checkpoints given on the map. On the sixth course, all participants went to the wrong checkpoint at least twice, and the mean number of times that these participants went to the wrong checkpoint was 3.4. The main movement types of the participants on the course were walking (S2, S5, and S6) and running (S1, S3, S4, and S7). Moreover, the length of time for the participants' problem-solving on the course ranged between 03 sec and 03 min 17 sec, while that of the course completion ranged from 03 min to 11 min 52 sec. All of the participants adhered to the code of conduct on the course.

Table 7. Findings related to corridor orienteering course-VI.

	Participants	S1	S2	S3	S4	S5	S6	S7
Orienteering Process: Understanding, Planning, Implementation, Evaluation	*Start*							
	Did the participant hold the map correctly at the start?	Yes	Yes	No	No	Partially	Yes	Yes
	Did the participant go in the right direction at the start?	Yes	Yes	No	No	Yes	Yes	Yes
	Process							
	Did the participant go to the checkpoints given on the map in the right order?	Yes	Partially	No	No	Yes	Yes	No
	Did the participant correctly punch the checkpoints given on the map?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Did the participant go to the wrong checkpoint?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	If so, how many times did he/she do that?	2	2	4	3	6	3	4
	What was the participant's main movement type on the course?	Running	Walking	Running	Running	Walking	Walking	Running
	What was the length of time for the participant's problem-solving for the course?	32 sec	01 min 22 sec	05 sec	03 sec	03 min 17 sec	44 sec	12 sec
	Did the participant adhere to the code of conduct on the course?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Finish							
	How long did it take the participant to complete the course?	03 min 49 sec	05 min 55 sec	03 min 02 sec	03 min	11 min 52 sec	03 min 51 sec	04 min 07 sec

Findings related to the seventh course are presented in Table 8.

Table 8. Findings related to corridor orienteering course-VII.

	Participants	S1	S2	S3	S4	S5	S6	S7
Orienteering Process: Understanding, Planning, Implementation, Evaluation	*Start*							
	Did the participant hold the map correctly at the start?	Yes	Yes	Yes	No	Partially	Yes	Yes
	Did the participant go in the right direction at the start?	Yes	Yes	Yes	No	Yes	Yes	Yes
	Process							
	Did the participant go to the checkpoints given on the map in the right order?	Yes	Yes	Yes	No	Yes	Yes	Yes
	Did the participant correctly punch the checkpoints given on the map?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Did the participant go to the wrong checkpoint?	Yes	Yes	No	Yes	Yes	Yes	Yes
	If so, how many times did he/she do that?	2	4	0	8	5	2	2

Table 8 (Continued). Findings related to corridor orienteering course-VII.

Participants	S1	S2	S3	S4	S5	S6	S7
What was the participant's main movement type on the course?	Running	Walking Running	Running	Running	Walking	Walking	Walking
What was the length of time for the participant's problem-solving for the course?	21 sec	01 min 05 sec	08 sec	13 sec	01 min 52 sec	25 sec	10 sec
Did the participant adhere to the code of conduct on the course?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Finish							
How long did it take the participant to complete the course?	03 min 59 sec	04 min 37 sec	02 min 09 sec	4 min 58 sec	08 min 32 sec	03 min 55 sec	01 min 37 sec

As seen in Table 8, findings related to the seventh course, i.e., corridor orienteering show that, at the start, some participants (S1, S2, S3, S6, and S7) were able to hold the map correctly; one participant (S5) was partially able to hold it correctly, while one participant (S4) failed to hold it correctly. While some of the participants (S1, S2, S3, S5, S6, and S7) went in the right direction at the start, the remaining participant (S4) was unable to go in the right direction. Some participants (S1, S2, S3, S5, S6, and S7) were able to go to the checkpoints given on the map in the right order, while one participant (S4) tried to find the checkpoints without following the checkpoint order. All of the participants were able to correctly punch the checkpoints given on the map. On the seventh course, all of the participants except for one (S3) went to the wrong checkpoint at least twice, and the mean number of times that these participants went to the wrong checkpoint was 3.2. The main movement types of the participants on the course were walking (S2, S5, S6, and S7) and running (S1, S2, S3, and S4). Moreover, the length of time for the participants' problem-solving on the course ranged between 08 sec and 01 min 52 sec, while that of the course completion ranged from 01 min 37 sec to 08 min 32 sec. All of the participants adhered to the code of conduct on the course.

Findings related to the eighth course are given in Table 9.

Table 9. Findings related to milk field (white paper) orienteering course-VIII.

	Participants	S1	S2	S3	S4	S5	S6	S7
Orienteering Process: Understanding, Planning, Implementation, Evaluation	*Start*							
	Did the participant hold the map correctly at the start?	Yes	Yes	Yes	No	Partially	Yes	Yes
	Did the participant go in the right direction at the start?	Yes	Partially	Yes	No	Yes	Yes	No
	Process							
	Did the participant go to the checkpoints given on the map in the right order?	Partially	Partially	Partially	No	Yes	Yes	No
	Did the participant correctly punch the checkpoints given on the map?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Did the participant go to the wrong checkpoint?	Yes	Yes	No	Yes	Yes	Yes	Yes

Table 9 (Continued). Findings related to milk field (white paper) orienteering course-VIII.

Participants	S1	S2	S3	S4	S5	S6	S7
If so, how many times did he/she do that?	2	9	0	4	11	6	3
What was the participant's main movement type on the course?	Walking	Running	Running	Running	Running	Running	Running
What was the length of time for the participant's problem-solving on the course?	49 sec	01 min 20 sec	05 sec	04 sec	01 min 12 sec	29 sec	08 sec
Did the participant adhere to the code of conduct on the course?	Yes	Yes	Yes	Partially (sometimes followed others)	Yes	Yes	Yes
Finish							
How long did it take the participant to complete the course?	03 min 49 sec	08 min 10 sec	02 min 24 sec	03 min 30 sec	06 min 41 sec	06 min 49 sec	03 min 02 sec

As seen in Table 9, findings related to the eighth course, i.e., white paper orienteering demonstrate that, at the start, some participants (S1, S2, S3, S6, and S7) were able to hold the map correctly, one participant (S5) was partially able to hold it correctly, while one participant (S4) failed to hold it correctly. While some of the participants (S1, S3, S5, and S6) went in the right direction at the start, one of the remaining participants (S2) was only partially able to go in the right direction and two of them (S4 and S7) were unable to go in the right direction. Some participants (S5 and S6) were able to go to the checkpoints given on the map in the right order, while some participants (S1, S2, and S3) partially followed the checkpoint order and some participants (S4 and S7) did not follow the checkpoint order at all. All of the participants were able to correctly punch the checkpoints given on the map. On the eighth course, all of the participants except for one (S3) went to the wrong checkpoint at least twice, and the mean number of times that these participants went to the wrong checkpoint was 5. The main movement types of the participants on the course were walking (S1) and running (S2, S3, S4, S5, S6, and S7). Moreover, the length of time for the participants' problem-solving on the course ranged between 04 sec and 01 min 20 sec, while that of the course completion ranged from 02 min 24 sec to 08 min 10 sec. One participant (S4) partially adhered to the code of conduct on the course, while the other participants adhered to this in full.

Findings related to the ninth course are presented in Table 10.

As can be seen in Table 10, findings related to the ninth course, i.e., white paper orienteering indicate that, at the start, some participants (S1, S2, S3, S5, and S6) were able to hold the map correctly, one participant (S7) was partially able to hold it correctly, while one participant (S4) failed to hold it correctly. While some of the participants (S1, S2, S3, S5, S6, and S7) went in the right direction at the start, one remaining participant (S4) was unable to go in the right direction. Some participants (S1, S5, and S6) were able to go to the checkpoints given on the map in the right order, while the other participants (S2, S3, S4, and S7) only partially followed the checkpoint order. All of the participants were able to correctly punch the checkpoints given on the map. On the ninth course, all of the participants except for one (S6) went to the wrong checkpoint at least twice, and the mean number of times that these participants went to the wrong checkpoint was 3.4. The main movement types of the participants on the course were walking (S2 and S7) and running (S1, S2, S3, S4, S5, and S6). Furthermore, the length of time for the participants' problem-solving on the course ranged between 05 sec and 02 min 08 sec, while that of the course completion ranged from 02 min 30 sec to 06 min 44 sec. All of the participants adhered to the code of conduct on the course.

Table 10. Findings related to milk field (white paper) orienteering course-IX.

	Participants	S1	S2	S3	S4	S5	S6	S7
Orienteering Process: Understanding, Planning, Implementation, Evaluation	*Start*							
	Did the participant hold the map correctly at the start?	Yes	Yes	Yes	No	Yes	Yes	Partially
	Did the participant go in the right direction at the start?	Yes	Yes	Yes	No	Yes	Yes	Yes
	Process							
	Did the participant go to the checkpoints given on the map in the right order?	Yes	Partially	Partially	Partially	Yes	Yes	Partially
	Did the participant correctly punch the checkpoints given on the map?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Did the participant go to the wrong checkpoint?	Yes	Yes	Yes	Yes	Yes	No	Yes
	If so, how many times did he/she do that?	3	6	3	6	2	0	4
	What was the participant's main movement type on the course?	Running	Running Walking	Running	Running	Running	Running	Walking
	What was the length of time for the participant's problem-solving on the course?	28 sec	02 min 08 sec	05 sec	12 sec	21 sec	08 sec	11 sec
	Did the participant adhere to the code of conduct on the course?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Finish							
	How long did it take the participant to complete the course?	05 min 51 sec	06 min 44 sec	03 min 03 sec	02 min 45 sec	02 min 30 sec	02 min 39 sec	05 min 37 sec

The stages that the participants followed while orienteering were evaluated according to the steps of Polya's problem-solving method. The findings obtained as a result of this are given in Table 11.

Table 11. Findings related to orienteering process according to Polya's problem-solving steps

Polya's Problem-Solving Steps (Polya, 1997)		Orienteering Process	Exercise	Participants
Orienteering Process: Understanding, Planning, Implementation, Evaluation	Understanding	Holding the map correctly Finding one's place on the map Reading the map	Arranging the map Making the necessary connections between the map and the related environment	S1, S2, S3, S4, S5, S6, and S7
	Planning	Making the necessary plan for reaching the checkpoint	Determining the route leading to the checkpoint from the place located on the map Determining the route leading to the checkpoint from the place located in the related environment	
	Implementation	Putting the plan into practice	Using the route specified at the planning stage in the related environment	
	Evaluation	Checking the accuracy of the checkpoint reached	Checking the accuracy of the checkpoint reached: If the wrong checkpoint has been reached, the process must be reviewed. If the correct checkpoint has been reached, the same processes must be carried out for the next checkpoint	

Participants' Feelings and Thoughts Related to the Orienteering Process

Following the implementation, the participants were asked to state their feelings and thoughts regarding orienteering. The findings obtained as a result of this are given in Table 12.

Table 12. Findings related to participants' feelings and thoughts about orienteering

Participants Views	S1	S2	S3	S4	S5	S6	S7
Orienteering was fun.	✓	✓	✓	✓	✓	✓	✓
Feelings	Happiness Health	Happiness Self-Confidence Excitement	Happiness Self-Confidence	Happiness	Happiness	Freedom	Happiness
Thoughts	Running	Checkpoint number Finding treasure	Sport	Running Game	Play Puzzle	Finding checkpoint Running	Running Finding treasure

As can be seen in Table 12, all participants stated that they enjoyed orienteering. When asked about the possible reasons for such enjoyment, the participants stated their feelings and thoughts revealing the following concepts of "happiness", "running", "checkpoint", "fun", "game", "puzzle" and "finding treasure".

The analysis results of the observations made by the researcher during the implementation support the findings related to the participants' feelings and thoughts about orienteering. The findings obtained in this regard are given in Table 13.

Table 13. Findings related to researcher's observations

Observations	Situations that were the source of the observations
Participants enjoyed orienteering and found it fun.	Participants' words and behaviors during the process can be interpreted to mean that they liked orienteering.
Participants were curious, interested, and willing towards orienteering throughout all the exercises.	After each exercise, participants stated that they were curious about the next course and asked when it would be done.
Participants began to hold and read the map more correctly during the exercises.	During the exercises, participants read the map better, and found the checkpoints more quickly and correctly (In this context, these results were obtained by comparing the data from each exercise with the previous ones).
Participants got adapted to orienteering with the head camera.	Participants stated that they found orienteering with the head camera enjoyable.
Participants experienced different problems in different orienteering courses. However, it can be suggested that participants displayed better and more assured performances as the exercises progressed.	In each exercise, participants orienteered in the same area but on courses prepared according to different orienteering techniques. Participants displayed better performances in terms of finding the checkpoints, thinking, and implementation as the exercises progressed (In this context, these results were obtained by comparing the data from each exercise with the previous ones).
Participants began to read and understand the map better as they advanced from the first exercise towards the last exercise,	Some of the participants were able to run towards the checkpoints without paying much attention to the map, but that in later exercises, they ran by paying more attention to the map.

Table 13 (Continued). Findings related to researcher's observations

Observations	Situations that were the source of the observations
During the implementation, participants orienteered with increasing willingness in the face of challenging courses.	It can be suggested that participants' words and behaviors during the process were an indicator of this finding.
Participants began to solve problems they encountered in the courses more rapidly.	Orienteering can involve certain difficulties between the start and finish. These can be stated simply as orienting and reading the map, finding the checkpoints correctly, punching, going to the wrong checkpoint, etc. It was observed that participants were able to solve these problems that they encountered throughout the exercises more easily as the exercises progressed (In this context, these results were obtained by comparing the data from each exercise with the previous ones).
The orienteering process involved certain stages.	In orienteering, participants tried to understand the map, plan where to approach the checkpoint from, implement this plan and finally, check the accuracy of the checkpoint.

As shown in Table 13, the observable situations (words, behaviors, gestures, etc.) that were the source of the findings demonstrate that the participants were interested, willing, and curious about orienteering and that they enjoyed themselves during orienteering. It appeared that the participants began to orient the map in a better way and to read it more accurately as the exercises progressed. As a result of this, the participants found the checkpoints on the course more successfully and derived a great deal of pleasure from orienteering. Moreover, it was apparent that the participants began to solve the problems they encountered on the course more easily as the activities progressed. For example, when a participant was unable to find a checkpoint, he/she continued orienteering by making a plan. Based on this, it was clearly seen that participants followed certain steps while orienteering. These steps included understanding the map, making a plan for finding the checkpoint on the map, putting the plan into practice, and checking the accuracy of the checkpoint.

DISCUSSION, CONCLUSION, and SUGGESTIONS

The results obtained in the current study can be discussed in two dimensions, the first of which include the findings related to the investigation of the orienteering process according to the steps of Polya's problem-solving method; and the second dimension includes the findings related to what the participants' feelings and thoughts were about orienteering.

The data analysis about the orienteering process revealed that the participants followed certain steps during orienteering. In this context, skills specific to each stage of orienteering can be mentioned. For example, participants who cannot orient the map correctly may not be able to make a successful start to orienteering; when they orient the map incorrectly, it is more likely that they will go in the wrong direction. In this context, a participant's correct orientation of the map can be considered as a correct start to orienteering. Therefore, in this process, it is a matter of whether the participant has ever encountered a problem, and got involved in a solution process related to that problem. As the participant attempts to find a solution to an unknown situation, he/she becomes ready and highly likely to solve the problem (Reys et al., 1998). For this reason, orienteering is a means that can be used for the development of problem-solving skills (Kelly, 2014), and can be used in mathematics education (Quenneville, 1979). At this point, it can be interpreted that orienteering is a process of doing mathematics. Therefore, it can be stated that orienteering has the potential to improve general problem-solving skills and improve mathematical problem-solving skills.

During the orienteering process, the findings relating to orienteering skills include the participants' ability to orient the map correctly at the start, go in the right direction, reach the checkpoints given on the map in the right order, punch these checkpoints correctly, and follow the code of conduct on the course, together with the probability and frequency of going to the wrong checkpoints. In this context, reading the map, taking a course, and following a route are among the basic skills of orienteering. Since the participants had no previous experience of orienteering, the fact that they faced various problems related to these skills can be regarded as a natural consequence. It appeared that the more they encountered problems about correctly orienting the map, locating the checkpoint, punching the checkpoint, going to the wrong checkpoint or checkpoints, and observing the codes of conduct on the course, the more they began to solve these more easily as the activities progressed. In this sense, it can be suggested that the participants made progress in exhibiting skills specific to orienteering and solving the problems they experienced on the course. The fact that the time taken by participants to solve the problems they met on the course decreased can be regarded as a factor that supports evidence of this progress. Within the framework of the data obtained from the participants' head cameras, the length of time for problem-solving were determined based on the parts in which they contemplated on the map and made plans. Accordingly, it was seen that between the first and last exercises, the length of time for most of the participants' problem-solving decreased. Similarly, the time that participants took to complete the course also decreased. However, the fact that the participants orienteered in the same area may also have had an effect on the decrease in the length of time for their problem-solving ability on the course. On the other hand, different course types were utilized for each exercise, and between the first and last exercises, the degree of difficulty of the course was gradually increased. Increases and decreases were determined regarding the length of time for participants to carry out the process according to the difficulty of the course. In this context, the participants' fondness for running games, the absence of any health conditions that prevent orienteering and their general interest in solving mathematical problems may have been effective in their success in problem-solving processes in orienteering. It can be said that the differences in the academic achievements of the participants in the mathematics course did not have a direct effect on the results. However, it can be said that there was a small difference between the thinking behaviors in the process of finding the checkpoints on the course considering the participants with low academic achievement in mathematics and those with high academic achievement. It can be said that students with high academic achievement in mathematics and who liked problem solving more tended to act more thoughtfully on the course. In other words, it was observed that all students enjoyed participating in orienteering. However, it was observed that students with higher academic achievement in the thinking processes of finding the checkpoints on the course spent more effort. Consequently, it can be stated that the implementation contributed to some extent to the participants' ability to solve the problems encountered more quickly since orienteering is a thinking person's sport (August, 1975; Hugglestone & Howard, 1983) and is also a problem-solving process that involves thinking (Bradford, 1977; Kjellstrom & Kjellstrom-Elgin, 2010). Moreover, orienteering also develops skills such as problem solving, decision making, and spatial thinking (Kelly, 2014). The study conducted by Taş (2010) concluded that people interested in the sport of orienteering were able to solve problems better than those who did not take an interest in it. Although the results of that study did not directly support the results obtained in the present study, they can throw light on the research findings to some extent. Furthermore, Uzuner and Şahin (2021) tried to improve attention, metacognition and problem-solving skills by teaching orienteering to children with ADHD in their study, as a result of which positive results were reported. Therefore, orienteering is an area that develops skills not only in certain disciplines (geography, physical education and sports) (İmamoğlu & İmamoğlu, 2018), but also develops deeper skills in other areas such as mathematical problem solving. In this context, Kaya (2020) stated that orienteering has relations with many learning areas and can be used in these areas. For that reason, in the context of problem solving, it can be interpreted that orienteering itself is a problem-solving process and can intuitively improve problem-solving skills.

Mathematical skills can also be used during orienteering (Balkwill, 1996; BSOA, 2015). Moreover, orienteering can also be used for teaching certain subjects in mathematics (angles, measurement, speed,

estimating, etc.) (BSOA, 2015; Kelly, 2014). Indeed, research has shown that orienteering has great interdisciplinary potential (Tammaro et al., 2017) and is effective in teaching cognitive skills (Huikko & Raus, 2020). Sezgin (2020) suggested the use of mathematics, physical education and orienteering to develop spatial skills. Besides, it has been reported that since orienteering has a physical and mental potential, it has properties related to abstract (long-term memory, short-term memory, planning, attention, etc.) concepts (Gölgeli, 2020). For example, orienteering was handled with the Quantum Learning Approach and as a result, it was seen that academic achievement increased (Beyaztaş, 2022). In this study, it is thought that there is an intuitive mathematical problem-solving process in the orienteering process based on these different studies. It is also stated that integrating physical activities into mathematics lessons is a practical pedagogical method (Sneck et al., 2020). The findings related to the fact that the orienteering process shows parallelism with Polya's problem-solving steps can be considered as a different contribution from what is known in the mathematics and orienteering literature. Therefore, the existence of the relationship between orienteering and the steps of Polya's problem-solving method can be investigated. In this way, the reasons for the benefits that orienteering provides for individuals can also be examined from a different perspective. According to the research findings, it can be suggested that the steps that the participants followed while engaging in orienteering corresponded with Polya's problem-solving steps to a certain extent. When the participants' orienteering process in all the exercises was considered, it was seen that some steps repeated themselves and came to the fore as an important finding. At the first stage, participants held the map correctly, found their place on the map, and read the map. At the second stage, participants made a plan for reaching the checkpoints given on the map. At the third stage, participants put their plan into practice to reach the checkpoints. At the final stage, participants checked whether they had reached the correct checkpoint in line with the plan they had determined. Participants who were unable to reach any checkpoint or who reached the wrong checkpoint realized they had made a mistake and began the process again. If the participant reached the correct checkpoint, then, in this case, he/she headed for the other checkpoints by following the same steps. Participants continually went through these stages during the orienteering process. It can be said that the steps followed by the participants in the orienteering process showed similarity with Polya's problem-solving steps (Polya, 1997). That is to say, first of all, understanding the problem, then developing a plan for solving the problem, implementing the solution plan that is developed, and finally, checking the accuracy of the result achieved about the problem, are involved in both processes. Consequently, it can be stated that within the scope of the findings obtained in the study, a participant engaged in orienteering also follows similar steps to the steps of Polya's problem-solving process. This study may, therefore, shed light on the development process of problem-solving skills of participants involved in orienteering. At this point, it can be argued that there is an intuitive process underlying the high interdisciplinary potential of orienteering. Besides, it can be stated that this process is like the problem-solving process designed by Polya.

As a result, this study revealed that individuals doing orienteering go through a problem-solving process and this problem-solving process is similar to Polya's problem-solving stages. Considering that orienteering has positive effects on individuals' cognitive skills, it can be thought that the source of these effects is related to problem-solving approaches from a different perspective. Besides, it was seen that the participants were physically and mentally active in the orienteering process and that their feelings and thoughts about this process were positive. In this context, participants expressed their feelings towards orienteering with the concepts of happiness, health, self-confidence, freedom, and excitement; while they expressed their thoughts with the concepts of running, checkpoint number, treasure, sport, game, and puzzle. Moreover, it was observed that the participants derived pleasure from orienteering with a head camera. Ekiz and Uzuner (2019) reported that primary school students liked orienteering and found it enjoyable. Consequently, participants were active, solved problems, and were active in this process. It can, therefore, be argued that orienteering has the potential to have positive effects on participants' feelings, thoughts, and behaviors.

Study Limitations

The results obtained in terms of the limitations of the present study may shed light on future research. The limitations of the study include the facts that it was conducted with only seven participants in five weeks, by using the same geographical area for orienteering, and was conducted only with 4th-grade students in primary school. It can, thus, be recommended to carry out studies that can contribute more to the relevant literature by taking these limitations into account. In other words, studies with different samples, data collection tools, implementation periods, and research methods can be done. In this way, the relationship between orienteering and the problem-solving process of Polya can be better explained. Further studies can be conducted to investigate the potential of orienteering in developing problem-solving skills. In this way, the steps that a person follows during orienteering can be seen more clearly, since orienteering is not only a sport, but is also an interdisciplinary educational tool (Larkin, 1976; BSOA, 2015; Bradford, 1977). Moreover, orienteering enables the use of skills targeted in curricula (BSOA, 2015), and problem solving is also one of the basic skills required for the new age (Altun, 2015; Baki, 2018; Ministry of National Education, 2018).

Directions and Implications for Practice and Future Research

It is recommended that studies be carried out in which similar and different research methods are used to examine the use of orienteering in the development of students' problem-solving skills, and in which orienteering is used for the teaching of Polya's problem-solving steps to children. The Higher Education Institution should add orienteering education to the training process of primary school teachers; the Ministry of National Education should provide primary school teachers with the necessary in-service training on orienteering, and orienteering should be included in one of the compulsory courses in primary school, such as mathematics. In short, orienteering should take its place in the curriculum as both a teaching technique and a learning area for instructors.

Ethics and Conflict of Interest

This paper was generated from Asst. Prof. Dr. Fatma Gül UZUNER's doctoral thesis, titled "An Investigation of the Effects of Orienteering on the Development of Primary School Students' Math Problem-Solving Skills". Ethical permission for this study was obtained from the General Secretariat of the Presidency of Trabzon University on 26.10.2018 with the number 81614018-25. Ethical principles were taken into consideration in this study. There is no conflict of interest between the authors.

REFERENCES

Aksın, K. (2019). *Oryantiring terminolojisi* [Orienteering terminology]. Ankara: Gazi Bookstore.

Altun, M. (2008). *İlköğretim ikinci kademe matematik öğretimi* [Elementary school second level mathematics teaching]. Bursa: Aktüel Alfa Academy Publishing.

Altun, M. (2015). *Eğitim fakülteleri ve sınıf öğretmenleri için matematik öğretimi* [Mathematics teaching for education faculties and primary school teachers] (19th edition). Bursa: Alfa Aktüel Academy Publishing.

Anderson, G. (2005). *Fundamentals of educational research*. Taylor & Francis e-Library.

Atakurt, E., Şahan, A., & Erman, K. A. (2017). The effect of orienteering education on attention and memory. *SPORMETRE The Journal of Physical Education and Sport Sciences, 15*(4), 127-134.

August, I. (1975). Orienteering: A thinking man's sport or it's nice to fool mother nature. In N. Skliar (Ed.), *The best of "The Communicator"* (pp. 71-74). Retrieved from ERIC database. (ED118307).

Baki, A. (2018). *Matematiği öğretme bilgisi* [Knowledge of teaching mathematics]. Ankara: Pegem Academy.

Balkwill, T. L. (1996). *Determinants of teacher participation in outdoor education: A survey of Kent County teachers*, (Unpublished master's thesis). University of Windsor, Faculty of Graduate Studies and Research, Canada.

Baykul, Y. (2016). *İlkokulda matematik öğretimi* [Mathematics teaching in primary school] (13th edition). Ankara: Pegem Academy.

Bektaş, F., Karademir, E., Kaya, S., Kalın, C., Şeker, T., Kurtoğlu, E., Öztürk, F., Arslan, E., Aydın, Ö., Ataklı, G., & Oymak, Ö. (2019). *Oryantiring eğitimi* [Orienteering training]. Ministry of Education.

Beyaztaş, M. K. (2022). *The use of orienteering game supported by quantum learning approach in teaching the natural systems unit of the 11th grade geography lesson*, (Unpublished master's thesis). Atatürk University, Institute of Educational Sciences, Erzurum, Turkey.

Boga, S. (1997). *Orienteering: The sport of navigating with map & compass*. Mechanicsburg, PA: Stackpole Books.

Bomgardner. R. (2014). *The relationship between education self-efficacy and aggregate physical fitness in children*, (Unpublished doctoral thesis). Liberty University, USA.

Bradford, D. (1977). Incorporating orienteering in school programs. Retrieved from ERIC database. (ED134384).

British Schools Orienteering Association (BSOA). (2015). What is orienteering? History and Objectives. 28 July 2020 retrieved from https://www.bsoa.org/

Cambridge Dictionary. (2021). 28 September 2021 retrieved from https://dictionary.cambridge.org/tr/s%C3%B6zl%C3%BCk/ingilizce/orienteering.

Campbell, M., & Burton, V. (1996). Orienteering map and compass: A guide and outline to its science and practice. Retrieved from ERIC database. (ED402131).

Celestino, T., & Pereira, A. M. (2012). The sport of orienteering: Performance of physically active people who partake in leisure activities but have no experiences in this modality. *Cultura, ciencia y deporte: revista de ciencias de la actividad física y del deporte de la Universidad Católica de San Antonio, 7*(19), 45-52.

Cordes, K. A., & Hutson, G. A. (2015). *Outdoor recreation: enrichment for a lifetime* (Ed. 4). Sagamore Publishing.

Creswell, J. W. (2016a). Nitel yöntemler [Qualitative methods]. In S. B. Demir (Ed.), *Araştırma deseni: nicel, nitel ve karma yaklaşımlar* [Research design: quantitative, qualitative and mixed approaches] (2nd edition) (Y. Dede, transl.) (pp. 183-213). Ankara: Eğiten Book. (Original book publication date: 2013).

Creswell, J. W. (2016b). Veri analizi ve sunumu [Data analysis and presentation]. M. Bütün & S. B. Demir (Eds.), in *Nitel araştırma yöntemleri: Beş yaklaşıma göre nitel araştırma ve araştırma deseni* [Qualitative inquiry and research design choosing among five approaches] (3rd edition) (A. Bacanak, transl.) (pp. 179-212). Ankara: Siyasal Bookstore. (Original book publication date: 2013).

Datta, L. (1990). *Case study evaluations*. Washington, DC: U.S. General Accounting Office.

Deniz, E., Karaman, G., Bektaş, F., Yoncalık, O., Güler, V., Kılınç, A., & Ateş, A. (2011). *Çocuklara oryantiring eğitimi* [Orienteering training for children]. Ankara: Kültür Ajans Publishing.

Di Tore, P. A., Corona, F., & Sibilio, M. (2015). Orienteering: spatial navigation strategies and cognitive processes. *Journal of Human Sport and Exercise, 10*(1), S507-S514.

Dinç-Artut, P., & Tarım, K. (2009). Investigation of the prospective teachers' problem solving process in the nonroutine word problems. *Journal of Uludag University Faculty of Education, 22*(1), 53-70.

Ekiz, D. (2007). Bilimsel araştırmalarda nitel veri analizi ve yorum [Qualitative data analysis and interpretation in scientific research]. In D. Ekiz (Ed.), *Bilimsel araştırma yöntemleri* [Scientific research methods] (pp. 189-217). İstanbul: Lisans Publishing.

Ekiz, D. (2009). *Bilimsel araştırma yöntemleri* [Scientific research methods] (extended 2nd edition). Ankara: Anı Publishing.

Ekiz, D., & Uzuner, F. G. (2019, October). İlkokul öğrencilerinin oryantiringe ilişkin metaforik algıları üzerine fenomenolojik bir araştırma [A phenomenological study on primary school students' metaphorical perceptions of orienteering]. 2nd International Elementary Education Congress, Muğla, Muğla Sıtkı Koçman University.

Ferguson, C., & Turbyfill, R. (2013). *Discovering orienteering: Skills, techniques, and activities*. United States of America, USA: Human Kinetics.

Gölgeli, T. (2020). *A case study on the effect of route characteristics on decision making in the sport of orienteering*, (Unpublished master's thesis). Middle East Technical University, The Graduate School of Informatics, Ankara, Turkey.

Hammes, R. (2007). Orienteering with adventure education: New games for the 21st century. *Strategies, 20*(5), 7-13.

Hodgson, C., & Bailie, M. (2011). Risk management: philosophy and practice. In M. Berry & C. Hodgson (Eds.) *Adventure education* (pp. 46-62). London and New York: Taylor and Francis e-Library.

Hugglestone, A., & Howard, J. (1983). Orienteering. In N. Dougherty (Ed.), *Physical education and sport for the secondary school student* (pp. 198-205). Retrieved from ERIC database. (ED231783).

Huikko, P., & Raus, S. (2020). Online orienteering guide for teachers. 28 July 2020 retrieved from https://www.theseus.fi/bitstream/handle/10024/337653/Petteri%20Huikko%20Stefano%20Raus.pdf?sequence=2

İmamoğlu, M., & İmamoğlu, A. (2018). Oryantiring sporunun ortaöğretim coğrafya ve beden eğitimi ve spor derslerinin kazanımlarına etkisi [Effect of orienteering sport on learning outcomes of geography and physical education and sport lessons in secondary education]. *The Journal of Kesit Academy*, (16), 198-207.

Karaca, F. (2008). *Oryantiring uygulamalarının ilköğretim programlarındaki fonksiyonelliği* [Functionality of orienteering practices in primary education programs], (Unpublished master's thesis). Gazi University, Institute of Health Sciences, Ankara, Turkey.

Kaya, S. (2020). *Investigation of the application process of orienteering activities used in education by trainers and branch teachers within different courses*, (Unpublished master's thesis). Trabzon University, Institute of Graduate Education, Trabzon, Turkey.

Kelly, N. (2014). *Orienteering made simple and GPS technology: An Instructional handbook*. United States of America, USA: Author House.

Kim, S. H. (2010). An exploration of the applicability of a recreational Orientierungslauf (orienteering) programme for urban cultural experience activities. *Journal of Hospitality, Leisure, Sports and Tourism Education (Pre-2012), 9*(2), 130.

Kiwi-O Manual. (2014). Orienteering for Schools. 21 July 2020 retrieved from https://www.orienteering.org.nz/wp-content/uploads/2014/07/Kiwi-O-Manual-2014-v2.pdf.

Kjellstrom, B., & Kjellstrom-Elgin, C. (2010). *Be expert with map and compass*. Canada: John Wiley & Sons.

Krulik, S., & Rudnick, J. A. (1989). *Problem solving: A handbook for senior high school teachers.* United States of America, USA: Allyn & Bacon.

Larkin, R. P. (1976). Map and compass skills for the secondary school (understanding topographic maps, developing compass skills, and orienteering). Retrieved from ERIC database. (ED125940).

Larkin, R. P., & Grogger, P. K. (1975). Map and compass skills for the elementary school. Retrieved from ERIC database. (ED138529).

Lenchner, G. (2005). *Creative problem solving in school mathematics*. Australia: Australian Edition Publisher.

Mayer, R. E., & Hegarty, M. (1996). The process of understanding mathematical problems. In R. J. Sternberg & T. Ben-Zeev (Eds.), *The nature of mathematical thinking* (pp. 29-53). Mahwah, New Jersey, NJ: L. Erlbaum Associates.

Merriam, S. B. (2015). Nitel araştırmalarda geçerlik, güvenirlik ve etik [Validity, reliability and ethics in qualitative research]. In S. Turan (Ed.), *Nitel araştırma desen ve uygulama için bir rehber* [A guide to qualitative research design and practice] (translation of 3rd edition) (E. Dinç, transl.) (pp. 199-228). Ankara: Nobel Publishing. (Original book publication date: 2009).

Merriam, S. B., & Tisdell, E. J. (2016). *Qualitative research: A guide to design and implementation*. John Wiley & Sons.

Ministry of National Education. (2018). Turkey's education vision. 28 September 2020 retrieved from http://2023vizyonu.meb.gov.tr/doc/2023_VIZYON_ENG.pdf.

Morisbak, I. (1982). Orienteering: An activity for handicappers. In G. M. Robb (Ed.) *The Bradford papers. Volume ii, proceedings from the 1981 institute on innovations in camping and outdoor education with persons who are disabled* (pp. 79-85). Retrieved from ERIC database. (ED224637).

Orienteering New Zealand. (2021). Introduction to Orienteering. 29 September 2021 retrieved from https://www.orienteering.org.nz/about-orienteering/introduction-to-orienteering/.

Özal, Z. D., & Girgin, Y. (2013, November). *Oyun ve matematik iç içe* [Game and math intertwined]. Marmara University-8th National Congress on Educational Administration. İstanbul, Marmara University.

Özcan, F. (2007). *Oryantiring sporunun ilköğretim öğrencilerinin sosyal bireysel davranışları ile matematik-matıksal zekâ gelişimleri üzerindeki etkisinin incelenmesi* [Investigation of the effect of orienteering sports on elementary school students' social individual behaviours and their mathematical-logical intelligence development], (Unpublished master's thesis). Dumlupınar University, Institute of Social Sciences, Kütahya, Turkey.

Patton, M. Q. (2014). Nitel analiz ve yorumlama [Analysis, method and reporting]. In M. Bütün & S. B. Demir (Ed.), *Nitel araştırma ve değerlendirme yöntemleri* [Qualitative research and evaluation methods] (A. Çekiç & A. Bakla, transl.) (p. 431-534). Ankara: Pegem Academy.

Polya, G. (1997). *Nasıl çözmeli? Matematikte yeni bir boyut* [How to solve it? A new aspect of mathematical method] (F. Halatçı, transl.). İstanbul: Sistem Publishing.

Posamentier, A. S., & Krulik, S. (2016). *Matematikte problem çözme* [Problem solving in mathematics] (L. Akgün, T. Kar & M. F. Öçal, Transl.). Ankara: Pegem Academy.

Pouya, S., Demir, S., & Demirel, Ö. (2017). Orienteering plays for disabled children. *Kastamonu University Journal of Forestry Faculty*, *17*(4), 608-618.

Quenneville, G. (1979). *Cognitive and motor performance in school orienteering*, (Unpublished doctoral thesis). Indiana University, Indiana, USA.

Reys, R., Suydam, M., Lindquist, M., & Smith, N. L. (1998). *Helping children learn mathematics* (5th ed.). United States of America, USA: Allyn & Bacon.

Schoenfeld, A. (1985). *Mathematical problem solving*. USA: Academic Press.

Sezgin, S. H. (2020). *Examining the development process of seventh grade students' spatial orientation strategies in the orienteering game environment*, (Unpublished doctoral thesis). Anadolu University, Institute of Educational Sciences, Eskişehir, Turkey.

Şimşek, H., & Yıldırım, A. (2011). *Sosyal bilimlerde nitel araştırma yöntemleri* [Qualitative research methods in the social sciences]. Ankara: Seçkin Publishing.

Sneck, S., Järvelä, S., Syväoja, H., & Tammelin, T. (2020). Pupils' experiences and perceptions of engagement during the moving maths programme. *Education 3-13*, 53(3), 419-434.

Strauss, A., & Corbin, J. (1990). *Basics of Qualitative Research: Grounded Theory Procedures and Techniques*. London: Sage.

Tammaro, R., D'Alessio, A., & Petolicchio, A. (2017). Orienteering: motivation, multidisciplinary, and skills. A project in a secondary school in the province of Salerno. *International Journal of Humanities and Social Sciences*, *9*(5), 34-40.

Taş, M. Y. (2010). *Oryantiring sporcuları ile sporcu olmayan bireylerin stresle başa çıkabilme becerileri* [Stress coping skills of orienteering athletes and non-athletes], (Unpublished master's thesis). Gazi University, Institute of Health Sciences, Ankara, Turkey.

The National Council of Teachers of Mathematics. (NCTM). (2000). *Principles standards for school mathematics*. Reston, VA.

Uzuner, F. G., & Şahin, M. (2021). Examining the effect of orienteering on the development of attention, metacognitive awareness and problem-solving skills of primary school students with ADHD. *Journal of Educational Leadership and Policy Studies, spec iss (Spr 2021).*

Vaskan, I., Koshura, A., Kurnyshev, Y., Moseychuk, Y., Tsybanyuk, O., Yarmak, O., & Galan, Y. (2019). Orienteering in the system of recreational and health-improving activity of student youth. *Journal of Physical Education and Sport*, *19*(Supplement issue 2), 489-494.