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Early Teaching Experiences of Pre-Service Mathematics Teachers with Low Vision: Challenges and Proposed Solutions [*]

Az Gören Matematik Öğretmeni Adayının İlk Öğretim Uygulamaları Deneyimleri: Güçlükler ve Çözüm Önerileri

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ABSTRACT

While the learning processes of individuals with visual impairment are frequently examined, less attention has been given to them becoming teachers. This may be considered problematic, particularly for teaching content that involves abstract and visual concepts, such as symbolic representations and diagrams. This study examines the challenges of pre-service teachers with visual impairment during their early teaching experiences and suggests possible solutions. The participant in this action research was a pre-service mathematics teacher with low vision. The data were collected through individual interviews, lesson video recordings, and lesson plan documents and analyzed with the content analysis method. At the end of the three action plans, functional solutions were presented to communication, classroom management, lesson plan design, and attention to students thinking challenges that the participants encountered in their teaching practices. The utilisation of concrete materials proved an efficacious method of facilitating both group work and individual progress, and thus the solutions proposed for mathematics teachers with low vision may be regarded as recommendations.

Keywords: *Pre-service mathematics teachers, Visually impairment, Low vision, Teaching experience, Action research*

ÖZ

Görme engelli bireylerin öğrenme süreçleri sıklıkla incelenirken, onların öğretmen olmalarına daha az önem verilmiştir. Bu durum, özellikle sembolik gösterimler ve diyagramlar gibi soyut ve

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görsel kavramları içeren içeriklerin öğretimi için güçlük olarak değerlendirilebilir. Bu çalışma, görme engelli öğretmen adaylarının ilk öğretmenlik deneyimleri sırasında karşılaştıkları zorlukları incelemekte ve olası çözümler önermektedir. Bu eylem araştırmasının katılımcısı, az gören bir matematik öğretmeni adayıdır. Veriler, bireysel görüşmeler, ders video kayıtları ve ders planı dokümanları aracılığıyla toplanmış ve içerik analizi yöntemi ile analiz edilmiştir. Üç eylem planının sonunda, katılımcıların öğretim uygulamalarında karşılaştıkları iletişim, sınıf yönetimi, ders planı tasarımı ve öğrencilerin düşünme becerilerine dikkat etme zorluklarına işlevsel çözümler sunulmuştur. Somut materyallerin kullanımı, hem grup çalışmasını hem de bireysel ilerlemeyi kolaylaştırmada etkili bir yöntem olduğu kanıtlamıştır ve bu nedenle az gören matematik öğretmenleri için önerilen çözümler araştırmanın birer önerisi olarak değerlendirilebilir.

Anahtar Sözcükler: *Matematik öğretmen adayları, Görme engelli, Az görme, Öğretim Deneyimi, Eylem araştırması*

INTRODUCTION

Individuals with visual impairment have equal rights as their peers without visual impairment in educational practices. They require special adaptations, arrangements and support to benefit from these rights (Cinarbas & Hos, 2020; Phelan, 1969). Therefore, governments also take precautions and include regulations in educational practices within the services they provide to individuals with disabilities (Special Education Services Regulation, 2018). Nevertheless, students with disabilities are among the isolated and underrepresented groups in higher education (Riddell, Wilson & Tinklin, 2005). Despite all precautions and adaptations, they may need help to gain professional skills or pursue further educational opportunities. Indeed, individuals with visual impairments may need more opportunities or experience difficulties in education in departments whose curricula consist of visual and abstract content knowledge (Aktaş & Argün, 2021a; Guinan, 1997). For example, individuals with visual impairments are exempted from advanced mathematics curricula (Aktaş & Argün, 2021a), and pre-service teachers' needs in education faculties cannot be satisfied (Guinan, 1997). Thus, there is a need to improve teacher education and practices for individuals with visual impairments who have been clearly demonstrated to be able to comprehend advanced mathematical content (Aktaş &

Argün, 2021a; Aktaş, 2022; Erhardt & Shuman, 2015; Figueiras & Arcavi, 2014; Godfrey & Loots, 2015). Therefore, given these challenges, there is a need to understand the experiences of pre-service teachers with visual impairment in a teacher education programme to improve their experience in higher education and encourage new policies to provide equal access to higher education institutions.

LITERATURE REVIEW

Pre-service Teachers and Visual Impairment

In the developing era, there are now different occupational groups and even innovative and advanced teaching practices for individuals with visual impairment (see Yu & Chunlian, 2019). However, the teaching profession is a field with gaps in contemporary science for research on individuals with visual impairment (Effendi, Suyudi & Ali, 2021; Tuncay & Kizilaslan, 2022). This gap emphasises the need to explore strategies conducted by educators with visual impairment who have managed to enter a teaching profession and establish their teaching career. Indeed, while they continue teaching, they encounter challenges and develop alternative strategies to deal with special situations in their career. Since the experiences of pre-service teachers with visual impairments are shaped by a complex interplay of personal assumptions, interpersonal dynamics, and institutional policies (Cinarbas & Hos, 2020), they are likely to face difficulties in designing lesson plans, maintaining communication and visualisation. Due to this gap, it is hard to change the opinions to solid ground to convince society about the teaching profession for teachers with visual impairment. While research on this gap is needed, studies of teachers with visual impairment in an ordinary classroom are exceptionally uncommon (see Effendi et al., 2021; Godfrey & Loots, 2015; Guinan, 1997; Tuncay & Kizilaslan, 2022).

The best starting point for observing and developing handicaps, challenges, and even successful professional competencies in the teaching profession may be the in-service graduate education period (Riddell et al., 2005). This is when professional experiences,

practices, and skills are acquired. Teaching experience, including professional competencies and skills, is positively and significantly associated with teacher effectiveness (Podolsky, Kini & Darling-Hammond, 2019). Research indicated that beginning and novice teachers are less effective than those with some experience, and teachers show the most significant gains from experience during their initial years in the classroom (Harris & Sass, 2011; Podolsky et al., 2019). Thus, since it is inevitable that teachers who do not prepare for the profession in the pre-service period wear out more during the in-service period, mentoring and induction support to novice or pre-service teachers can lead to accelerated professional growth and improved student learning (Ingersoll & Strong, 2011). Mentoring should include professional skills such as instructional decisions, classroom management, student motivation, individual differences, different learning styles, and behaviour problems that can be challenging for beginning teachers (Onafowora, 2005). Moreover, teachers should be able to identify the change that they and their students need. However, teachers alone in the classroom often have to solve problems without the experience of others (Moore, 1994). Teachers can receive in-service training and advice from expert teachers, or pre-service teachers can imitate their mentor teachers to cope with these problems (Ingersoll & Strong, 2011). However, it may be difficult for mentor teachers or educators to perceive visual impairment or recognize needs. Therefore, the situation is unfamiliar for teachers and pre-service teachers with visual impairments. Therefore, there is a need for detailed research on requirements and solutions for teacher education based on visual impairments.

Visual impairment is classified according to the level of utilization of the sense of vision and the visual space indicating the distance at which vision is possible. Thus, the degree of disability of individuals is determined according to their level of utilization of the sense of sight in educational practices (Çakmak, Karakoç & Şafak, 2016). Therefore, individuals with low vision may have the colour or light perception, read large-font Latin texts, or carry out their daily and educational lives with a white cane, magnifying glass, or electronic devices. These differences are, of course, not only effective from the student's perspective but also require differentiation in classroom practices as a teacher.

For example, textbooks, boards, and visual aids (such as a female student with black hair) are challenges that a teacher with visual impairment has to encounter. The limited availability of teaching materials and access to practices in different textbooks also makes the lesson time-consuming and demanding (Juhász, 2011). Moreover, Juhász (2011) emphasised that it may be essential for the teacher to know by heart or to look at the lesson plan, activity, or problems designed by the teacher. For this reason, they may need to know effective memory techniques. Therefore, it is crucial to do constant mental background activities with their brain maintaining an alert all the time to handle the lesson.

Visual impairment poses a significant challenge for the teacher in written and verbal communication. Indeed, using the blackboard or written texts are a convenient tool for teachers to practice their art. Writing on the blackboard while simultaneously explaining allows them to maintain communication while also emphasizing the key points that teachers intend to convey to their students (Merri & Monties-Cabot, 2005). For example, it is a competence for a teacher with low vision to learn to write in large font on the blackboard (Tarsidi, 2005). Although smart boards and projectors are available as aids for teachers with disabilities, it is still not common to find a smart board in every classroom. In rural areas, teachers need access to technology-supported facilities in schools, and even pre-service teachers do not have access to them in universities (Aktaş & Argün, 2021a; Merri & Monties-Cabot, 2005).

Teachers with visual impairments face critical problems while verbally communicating with students, such as asking questions, getting answers, and making eye contact. Since addressing students by their names while asking questions would be the most effective way, they have to memorize students' names in the classroom (Juhász, 2011). Therefore, memorizing has become a requirement of classroom management (Tarsidi, 2005). Furthermore, the teacher with visual impairments can emphasize that s/he is listening or communicating with the students by touching their shoulders or chairs (Juhász, 2011). Moreover, teachers should masterfully use their hearing skills to respond to student feedback and control the classroom environment (Yu & Chunlian, 2019). Effendi et al.

(2021) observed that teachers with visual impairment frequently used pair or small group work, which sighted students found instructive. However, it was determined that it was difficult to include each student in the teaching practice at the same pace and to control written feedback for the teachers. They require technological or sighted support to review written text-based assignments or feedback (Juhász, 2011).

Mathematics Teacher with Visual Impairment

In the literature, teachers' experiences have been shared for disciplines such as English language teaching, which generally rely on verbal expression and can only be taught with the support of reader programs or slides (Juhász, 2011; Merri & Monties-Cabot, 2005; Yu & Chunlian, 2019). These studies also emphasized the difficulty of symbolic spellings such as Chinese characters (see Yu & Chunlian, 2019). However, mathematics and statistics are disciplines that are based on symbolic language but have received less attention (see Godfrey & Loots, 2015; Phelan, 1969). These studies made overcoming difficulties with discourses, tactile materials, graphics, and software possible. Despite these results, it is not only the fact that mathematics is a collection of symbols that contributes to the negative judgments about mathematics in learning and teaching processes but also the role of written and verbal mathematical language in communication. Indeed, symbols, discourses, and graphs or tables are the elements that constitute mathematical language, and which pre-service mathematics teachers have difficulties with (Aktaş et al., 2021b). In addition, chalkboards are often preferred for the continuity of mathematical operations (Godfrey & Loots, 2015; Phelan, 1969). However, abstract symbolic language, written language, and visual communication cause difficulties for individuals with visual impairment (Aktaş & Argün, 2020, 2021a; Erhardt & Shuman, 2015; Figueiras & Arcavi, 2014; Godfrey & Loots, 2015; Phelan, 1969). Therefore, the handicaps and challenges of teaching professional skills for pre-service mathematics teachers with visual impairment are remarkable and likely to reveal critical results for other disciplines.

Given the challenges of mathematical language for individuals with visual impairments, the current study focuses on the search for a solution to the difficulties identified by a pre-

service mathematics teacher with low vision during the teaching experiences by applying to an academic lecturer as an expert. Given the limited professional choices and educational offerings for students with visual impairment, it is unlikely that the lecturer will encounter an undergraduate student with visual impairment (Godfrey & Loots, 2015). In fact, as a result of the meta-synthesis study, it was pointed out that the studies conducted for visually impaired in-service and pre-service teachers in the literature could be more extensive (Lima & Ivy, 2017). Therefore, the study aims to identify the challenges faced by a pre-service mathematics teacher with low vision in her early teaching experiences and evaluate the effectiveness of the proposed solutions. The research process was designed and strengthened by combining the pre-service teacher's experience and the author's academic knowledge and experiences as a lecturer. Thus, the research emerged as a collaborative action research. Indeed, collaborative action research is based on daily practical problems teachers encounter in the classroom (Meier & Henderson, 2007). Also, collaborative action research is particularly suited to addressing these real-world challenges by providing immediate and practical solutions in a classroom setting. The power of collaborative action research rests with the ongoing nature of professional development in real classrooms with teachers confronting real problems. Consequently, the study results have been obtained to provide a basis for mathematics teachers and pre-service teachers with visual impairment, their educators, and researchers. In light of the aforementioned challenges, this study seeks to address two key questions:

1. What challenges pre-service mathematics teachers with low vision encounter in teaching experiences?

2. What are the proposed solutions for these challenges determined?

METHOD

The Emergence of Research and the Role of the Researcher

Pre-service teachers with low vision studying at the Faculty of Education, where the researcher was working, encountered various challenges with the Teaching Practice course in the last year of their departments. They communicated these problems to the researcher who teaches Special Education and Inclusion and Teaching Practice courses. Thus, a ten-week research process started with two pre-service teachers with visual impairment in the Departments of Elementary Mathematics Education and Turkish Language Education. The main study was conducted with a pre-service mathematics teacher, and the pilot study was conducted with a pre-service Turkish teacher. While the present study primarily concerns pre-service mathematics teachers, the pilot study was conducted with the pre-service Turkish teacher due to the shared experience of visual impairment and difficulty locating participants in this context. In the research process, the researcher assumed the roles of a clinical supervisor and an expert based on her research and lectures about individuals with visual impairments, classroom practices, and teacher training. In addition, she only watched the videos, collected data through interviews, and acted as a researcher during the classroom practice process.

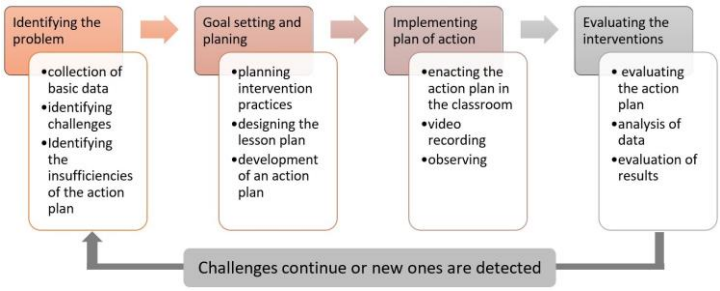
Research Design

Action research is a methodology that enables the examination of one's learning to ascertain its alignment with established norms. In the event of a necessity for improvement, an appropriate course of action can be implemented and the efficacy of the intervention demonstrated (McNiff, 2002). Collaborative research engages teachers in work teams and allows them to reflect upon their pedagogical practices. Thus, collaborative action research aims to comprehensively understand teachers' problems, issues, and practices in authentic settings. This helps bridge the gap between theory and practice (Stringer, 1996). Also, a commitment to educational improvement is at the heart of collaborative action research between academics and teachers (McNiff, 2002). Furthermore, collaborative action research between academics and teachers is a

commitment to educational improvement. Thus, the benefits of the collaborative action research method are the power given to pre-service and in-service teachers to inform their practice, such as classroom management and disruptive behaviors, and develop their intellectual capacities (Mitchell, Reilly & Logue, 2009). Therefore, this research aims to eliminate the difficulties encountered by the pre-service mathematics teacher with low vision in teaching experiences. The research was designed as collaborative action research because of the purpose of the research and the emergence process of the problem.

The research stages were conducted for collaborative action research: (i) identifying the problem, (ii) goal setting and planning, (iii) implementing the plan of action, and (iv) evaluating the interventions. Three action plans were prepared. In identifying the problem stage, the pre-service mathematics teacher carried out the classroom practice and identified the challenges. Also, the researcher observed through video recording. In the goal setting and planning stage, the practices designed by the pre-service mathematics teacher were analyzed with the researcher and the pre-service teacher and discussed for proposed solutions. In the stage of implementing the plan of action, the pre-service teacher designed the lesson plans and video-recorded her practices. In the last stage of evaluating the interventions, the functionality and effectiveness of the implemented proposed solution were evaluated, and the necessity of a new action plan was discussed. Thus, three action plans were carried out cyclically until the pre-service mathematics teacher could conduct an individual effective lesson (see Figure 1).

Figure 1. Procedure of Collaborative Action Research



Participant

Yıldız (code name) was a female final-year undergraduate student majoring in mathematics education who participated in the study. She was selected through purposeful sampling. Purposeful sampling is a qualitative research technique employed to identify cases, who possess knowledge about a given subject, that are rich in information based on relevant criteria (Creswell, 2012). Yıldız was born with low vision. She had requested the continuation of the research process herself. She completed her education background in inclusive classrooms. She could read 16 font-size texts. Her visual space was limited and her field of view is 16 degrees. She rarely preferred to wear glasses. She also needed sighted reader support during exams. However, she did not have sighted assistance. The only technological equipment she could use was the telephone. These limitations shaped her educational experience, which is detailed below. The first three years of the Elementary Mathematics Education program consisted of courses on basic content knowledge (calculus, geometry, etc.) and pedagogical content knowledge (teaching numbers, teaching geometry, etc.). In the final year, which is the fourth year, the Teaching Practice course comprised six lessons per week for two semesters. This included observation, along with practice sessions in middle schools. The course content for the twelve-week fall semester limited the number of teaching practices to three weeks. In contrast, the spring term required twelve weeks of practice. Yıldız conducted the classroom practices alone during the action research. Thus, it was aimed to provide the ability to overcome difficulties individually before the profession. Yıldız, who determined the challenges in the practices of the fall semester, conducted the action research together with the researcher for the practices of the spring semester. Yıldız carried out her teaching practices in a state middle school providing education at the 5th-8th grade level. During the Teaching Practices course, Yıldız followed the same 8th-grade class each week and gained teaching experiences. The class consisted of 24 students preparing for the high school entrance exam.

Data Collection

The data collection process covered five weeks including the initial situation assessment, three action plans, and the final evaluation. A total of six courses over three weeks in the

fall semester and four courses in the first two weeks of the spring semester in which the action research was carried out provided sufficient observations and experience opportunities to identify problems. In addition, Yıldız's courses were video recorded for two to four courses per week during the action research periods. Research data were collected through weekly interviews and video recordings. The content of the interviews consisted of the lesson plans designed by Yıldız and the analyses of her observations and experiences during the implementations. The identification of challenges and implementation evaluations were made through relevant questions such as 'What challenges arose during implementation?', 'Were there any inadequacies in the plan?' and 'Did the design's proposed solutions eliminate the challenges?'. The action plan was evaluated after the researcher watched the weekly recordings of Yıldız's course. These interviews were conducted in the researcher's room or via phone applications (whatsapp) for spontaneous ideas and were video or audio recorded. The evaluation of the action plan was based on satisfying the participant's needs (eliminating needs and challenges due to visual impairment), achieving the purpose of the course learning outcome, and eliminating the challenges. The researcher in charge of evaluating the action plan conducted the final evaluations based on the following criteria: (i) achieving the learning outcome, (ii) including proper strategies for visual impairment, (iii) including practices that eliminate the identified challenge, (iv) eliminating the factors that cause a new challenge by identifying them in advance, (v) confirming the accuracy of the mathematical content, (vii) evaluating the introduction, development, and conclusion steps of the lesson plan, (viii) considering the levels of middle school students.

Data Analysis

The data obtained from video and audio recordings were transcribed and analyzed with ongoing analysis. The analyses were enriched with the participants' evaluations and participant confirmation was obtained. At the end of each action plan and after the action research was completed, an overall evaluation was carried out through retrospective analysis. Retrospective analysis is usually conducted following the data collection phase and focuses on improving thinking processes and analysing the reflections of the

instructional intervention (Steffe & Thompson, 2000). The content analysis method (Creswell, 2012) was used to identify challenges. For example, for the *communication* theme, 'making eye contact' and 'pointing to the student' codes were created for the category of *initiating communication*. Likewise, for the *attention to students thinking* theme, 'checking student answers' and 'focussing on discourse' codes were included (see Table 1).

Table 1. Samples of Data Analysis

Theme (challenges)	Code (indicators of challenge)	Data
Communication	Pointing to the student	"If I noticed the colour of the students' clothes, I would call out the colour. But I pointed with my finger or went up to him and touched him."
Attention to students thinking	Checking students answers	"[…] After the time is up, the students present their solutions to me. I then ask them to explain their reasoning verbally. If a mistake is identified, the student is warned verbally, or we rectify the error together on the board. […]"

Validity and Reliability

Before the research process, a pilot study was conducted with a pre-service male teacher with low vision who was a final-year student in the Turkish Language Education program at the same faculty. As a result of the pilot study, it was concluded that challenges related to classroom management and communication skills were encountered more frequently

and that attention should be paid to these issues in the action plans. For the action plans, confirmation was obtained from a mathematics education specialist (assistant professor) and a special education specialist (assistant professor), who were determined to be a validity committee. In addition, these experts were consulted for analysis. Accordingly, although the attention to students thinking theme formed the basis of the other themes, it was decided to treat it as a separate theme. Thus, the points to be considered in solution proposals were emphasized. Obtaining peer review and member checking are processes that increase the validity of the research. Also, ethical principles were followed for the pilot study and action research.

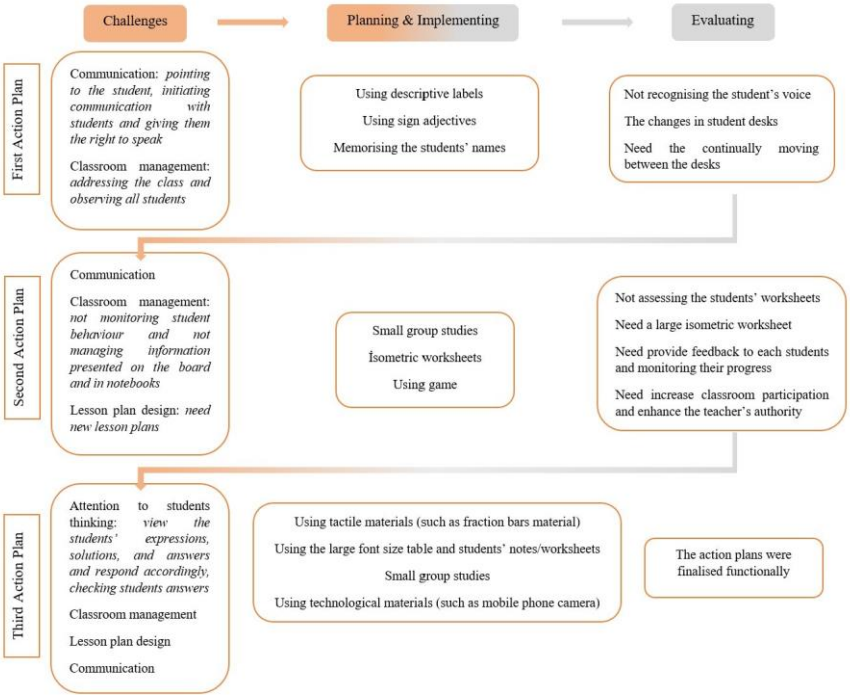
Research and Publication Ethics Statement

This study was carried out with the approval and under the scrutiny of the Ethics Committee of Kahramanmaras Sutcu Imam University (E-72321963-605.99-23560) and complied with the rules of research ethics imposed by the Council of Higher Education. The author declares that there is no conflict of interest.

RESULTS

The results have been presented according to the action plan cycles. Thus, the challenges faced by the pre-service mathematics teacher with low vision and the effectiveness of the proposed solutions have been demonstrated. Additionally, an evaluation of the action plan is feasible. The following presents detailed results of the action plans illustrated in Figure 2, organized according to the sub-headings provided.

Figure 2. Results for Action Plans



First Action Plan

One week before designing the first action plan, Yıldız delivered a one-hour lecture. Thus, the identifying the problem stage was conducted to examine the challenges that Yıldız had identified before individually and to identify any additional challenges. After recording the lesson on video, Yıldız articulated the challenges she had identified in the following manner:

> Yıldız: There were no issues with my conceptual knowledge or lesson plan. For instance, while granting a student the right to speak, I directed my gaze toward them, but the student perceived it as if I were looking elsewhere.

The video analyses concluded that Yıldız gestured towards the students with her finger, allowed them at the front desks to speak, and maintained eye communication. Yıldız

moved briskly between the desks and frequented the whiteboard area to exert control over the class. Yıldız explained this situation in the following way:

> Yıldız: On the whiteboard, my visual space is limited to the first three rows, and I tend to focus on only one side. For example, my attention may be drawn to the right side, leaving me unable to keep track of the left side. Due to limited focus, minor details may be overlooked. I try to view the entire class, avoiding prolonged fixation on a single area.

Accordingly, the challenges for the first action plan were determined to be *communication* and *classroom management*. The communication theme includes initiating communication with students and giving them the right to speak. The theme of classroom management consists of addressing the class and observing all students. Therefore, Yıldız proposed certain goals for the planning phase:

> Yıldız: I am attempting to memorize the students' names. I will address them accordingly. I can empower the students to voice their thoughts by approaching them and seeking collaborative solutions to any problems.

In addition, it was decided that Yıldız chose students who raised their hands using descriptive adjectives based on their clothing colors and called them to the whiteboard by extending the board pen. As a last option, she allowed the students who thought they were pointed out to opt-out as a way of escape until Yıldız's discriminatory skills developed enough.

In the following week, during the implementation phase, Yıldız taught the concept of first-degree inequalities with one unknown in her lesson. During the practice phase, she frequently moved between the desks of the students, touched the student she was going to give the right to speak, provided a pen, or applied various descriptive labels. Yıldız addressed the students by their names, those whose names she had learned. For this, Yıldız had to either recognize the student's voice, be close enough to hear them, or be physically close to the student. This was because Yıldız had noticed that the students had switched desks from the previous week. She had to continually move between the desks

for *classroom management*. She attempted to make eye contact with each student. However, in this way, she had to be quite active in the classroom. Once more, she was unable to observe all of the students. So, these strategies were helpful, but some issues persisted, leading to the need for the next action plan. Therefore, the evaluation of the first action plan revealed challenges for the second action plan.

Second Action Plan

When evaluating the first action plan with Yıldız at the end of the second week, it was determined that although the *communication* challenge had been addressed significantly, the *classroom management* challenges persisted. Yıldız had to put much effort into *managing the classroom*. Yıldız frequently moved between the desks and occasionally positioned themselves in front of the blackboard to observe the whole class. The video showed that this situation also distracted some students. Yıldız explained the challenge of monitoring students' progress in *classroom management* and proposed a solution as follows:

> Yıldız: When a problem is written on the board, the students are given a specific period. After the time was up, the students presented their solutions to me. I then ask them to explain their reasoning verbally. If a mistake is identified, the student is warned verbally, or we rectify the error together on the board. It poses a challenge for me to read through their notebooks.

Yıldız faced challenges when checking the solutions in her students' notebooks. Moreover, she had trouble deciphering both her students and her own notes on the whiteboard. Due to the text's small size on the whiteboard, she needed to stand close to it. Yıldız attempted to stand closer to the board, especially when presenting conceptual knowledge:

> Yıldız: When I used the blackboard with middle school students, they requested that I write in large letters. However, they did not want the letters to be huge, such as 14-point font.

Under the theme of *classroom management*, the second action plan identified the challenges of monitoring student behaviour and managing information presented on the board and in notebooks. This challenge restricted the partial resolution of the *communication* issue. The primary challenge was identified as *lesson plan design* to prevent students from engaging in off-topic conversations, increase classroom participation, and enhance the teacher's authority. A lesson design was collaboratively developed with Yıldız to address this challenge, involving small group studies with two students (see [7]). It was additionally decided that isometric worksheets should be distributed to groups, facilitating students' ability to articulate their ideas more comfortably. The isometric worksheets were selected due to their potential to facilitate tactile learning and group engagement, addressing both Yıldız's visual limitations and the need for more student collaboration. In the implementation of the action plan, the students were instructed to draw a line segment in each turn by following the rules of the XOX game using the isometric worksheet points. Consequently, the students were required to create triangles. Afterward, the students were tasked to gather evidence about the triangle inequality rule by calculating the lengths of the sides of the triangles they made (see Figure 3). Furthermore, Yes or No options were provided for Yıldız to review the student's answers for the evaluation step promptly. Thus, quick feedback was obtained on forming a triangle with the given numerical side lengths. By drawing an isometric structure on the board, the opportunity to discuss with the whole class and to examine some student examples was created. However, Yıldız explained the inadequacy of this practice as follows:

> Yıldız: There were no issues when I demonstrated on the blackboard, but I encountered a challenge when assessing the students' worksheets. I had to scrutinize the worksheets. I struggled to keep up again because of the large number of small groups. It would have been preferable to use a large isometric worksheet and display it on the board.

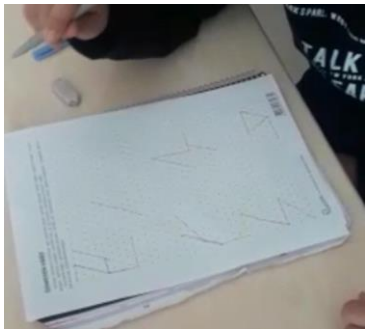


Figure 3. Solutions to Problems on Isometric Worksheet by Students

In the evaluating the interventions phase with Yıldız, the suggestion was made to use A3 paper on the board for teachers to present information to students. Yıldız stated her intention to design another lesson plan to increase the number of students in each group. After completing her lesson, Yıldız noticed that she could not provide feedback to each student individually and monitor their progress.

Third Action Plan

Having implemented and refined several action plans, Yıldız reflected on the tools and strategies that proved most effective. The second action plan revealed that group work efficiently tackles *communication* and *classroom management* challenges. However, *attention to students thinking* emerged as a new challenge that attracted more attention than whole class practices. The thoughts that include students' answers, feedback, ideas, and comprehensions and are determined by their discourses are considered as students thinking. Yıldız had to view the students' expressions, solutions, and answers and respond accordingly. Unfortunately, she could not analyze the notes since she did not have the opportunity to see them despite the group work. It was discovered that this outcome hindered the resolution of *classroom management* challenges. Furthermore, it was decided to administer a quiz at the end of the lesson to facilitate progress analysis. The process by which Yıldız evaluated student papers was also identified as a challenge. These challenges were identified as goals, and planning was carried out accordingly.

Thus, the *lesson plan design* included the fraction bars material for Yıldız to evaluate through tactile means. A table with a large font size was drawn on the board. The students were separated into groups of five individuals each. The participants were instructed to create tables using a larger font size in their worksheets. This instruction was intended to simplify the recognition, evaluation, and feedback on the students' answers, thoughts, and progress for Yıldız.

In implementing plan of action phase, Yıldız occasionally sought assistance from students when using the material but observed the triangles formed by the students by examining and describing them. Furthermore, she demonstrated her ability to indicate specific cells on the large table she drew by approaching the board (see Figure 4).

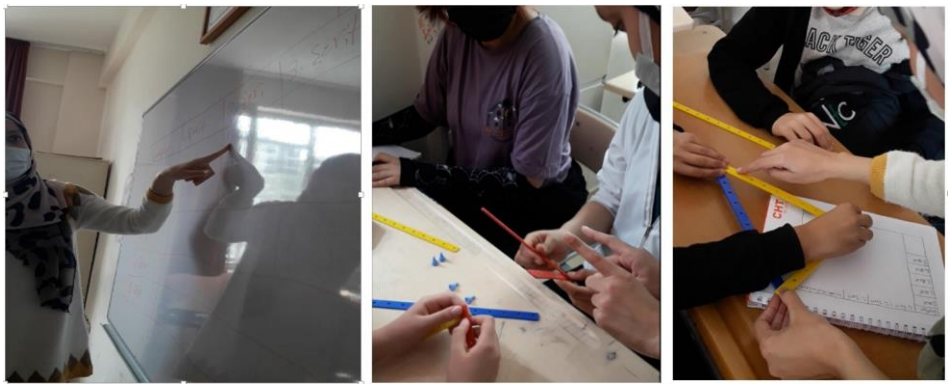


Figure 4. The Use of Material and Board by students and Yıldız

Yıldız examined the solutions and tables in the small groups' notebooks by approaching them and inspecting them closely. Whenever students requested to speak, she felt obliged to approach them personally (see Figure 5). These practices afforded Yıldız the opportunity to provide individualized feedback to the students and to conduct a comprehensive analysis of their responses.

Figure 5. Yıldız was Reviewing the Tables of Groups

The practice was assessed as follows by Yıldız:

> Yıldız: This material was beneficial. Direct counting was possible through tactile feedback. So, I could readily determine the length when constructing a triangle. The distance between the holes was accepted as a single unit. One representative from each group was called to the board simultaneously. I quickly checked each strip's lengths since they disclosed them to me. Using tables was beneficial. The students never perceived any inadequacy on my part.

It was determined that the students utilized the number of holes instead of the unit. The problem was resolved after Yıldız instructed them to recheck. The students' lack of pre-knowledge resulted in this situation. Furthermore, the students, who were supposed to create various triangles with the aid of the material, designed them on the same model (see Figure 6). Likewise, the purpose and objective of the material should have been comprehensively explained. Nevertheless, Yıldız found it quite challenging to convey her message to the students at the beginning of the lesson due to the classroom's noise level.

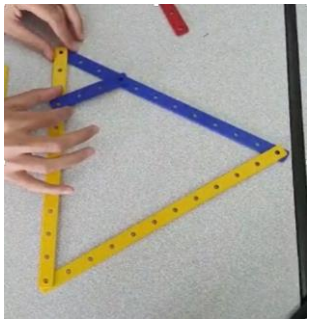


Figure 6. Incorrect Designs of Students

In addition, Yıldız was able to detect and correct students' misconceptions by using the materials and *lesson plan*. Yıldız explained her greater *attention to student thinking* as follows:

Yıldız: Their misconception was revealed when they took the triangle with unit lengths 7-7-3. They assumed there would always be an isosceles triangle, as in the equilateral triangle. I suggested, 'Let's check if it is a 3-3-7 triangle.' They experimented using the material and observed that it was not. I mean, they concluded that generalization is not applicable when two sides are equal. I instructed them to investigate situations where the length of the three sides of the triangle was unequal, and they were able to identify a non-existent example. Together, we generalized completing the table (see Figure 7).

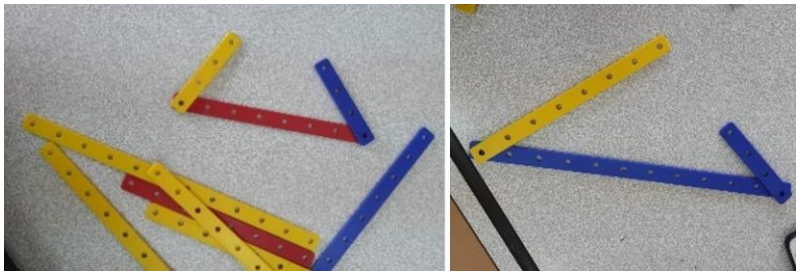


Figure 7. Students' Misconceptions via Materials

The use of materials encouraged the students to think more and facilitated students' expression of ideas. Incorporating large font text, tables, and small groups made it easier for Yıldız to monitor student progress and enhance *communication* among students. Additionally, Yıldız created the quiz papers in large font size, then reduced the font size and reproduced the papers. Yıldız took a picture of each paper with her phone to evaluate the quizzes and zoomed in. She had marked the end of each question to ensure that she could read easily and differentiate each question and score them correctly.

CONCLUSIONS

Communication and classroom management that emerged due to communication were the first challenges identified. Accordingly, the participant constantly walked between the desks, touched the student to whom she would have the right to speak, held out a pen, or used various sign adjectives during the communication process with students whose names she did not know or was not close enough to. Although attempts were made to address communication challenges, the difficulty of managing the classroom compounded these issues. For this reason, classroom management has been determined as an essential challenge for the second action plan. In this context, checking students' notebooks and classroom blackboards has been challenging. It has been determined that these challenges also trigger the communication problem. However, to eliminate these problems, the lesson plan design challenge was chosen as the fundamental challenge to increasing communication with students, strengthening participant control, and growing mastery. To address these ongoing challenges, a new lesson plan was designed. A lesson plan was designed with group work, materials, and games. However, the issues of feedback to students and using the blackboard were inadequate. The challenge of attention to students thinking has emerged based on the difficulty of following students individually. This difficulty also posed a classroom management challenge. In addition, the problem of evaluating written answers was also identified. For this reason, small group work, the lesson plan with tactile materials, and large font Latin texts on the blackboard and in student notebooks have been included. Overall, the integration of small

group work, tactile materials, and large font texts provided substantial improvements in managing the classroom, enhancing communication, and the problems of assessing student progress.

DISCUSSION AND SUGGESTIONS

The challenges faced by pre-service mathematics teachers with low vision during their early teaching experiences were grouped into four themes: *communication*, *classroom management*, *lesson plan design*, and *attention to students' thinking*. Each of these challenges is associated with visual impairment. In light of these results, each of these challenges is interrelated. The difficulty in making eye contact with students has a negative impact on *communication* and consequently affects *classroom management*. Hence, it is necessary to include supportive educational materials and teaching strategies that facilitate implementation in the *lesson plan*. As *communication* and *classroom management* improve, the *attention to student thinking* increases. Thus, raising students' academic success and promoting learning is possible. This result implies not only the resolution of challenges via enhanced professional skills. Physical factors are also responsible for hindering progress, highlighting inadequacies. For instance, overcrowded classrooms with long desks limit movement and hinder various activities. Integrating professional and physical equipment to overcome these hurdles and resolve these challenges is crucial.

Teachers often use strategies such as descriptive adjectives, pointing with a pen or finger, touching the student, and moving between desks to overcome the challenges of initiating communication and giving them the right to speak. These strategies have been frequently emphasized in the literature (Juhász, 2011; Tarsidi, 2005; Yu & Chunlian, 2019). As time passes and the pre-service teachers' other senses come into play, they can address students by their names with distinguished voices or physical qualities despite having low vision. Increasing *communication* can enhance *classroom management* success. However, dealing with students individually requires considerable effort. The main difficulties recognized are reading students' notebooks and solutions, texts on the blackboard, and

their own notes (as previously highlighted by Merri & Monties-Cabot, 2005; Tarsidi, 2005). To overcome common *communication* and *classroom management* challenges, it is essential to change the *design of lesson plans*. Alternative assessments, instructional games, or group work may be included along with *lesson designs* such as isometric worksheets or larger print. Nevertheless, personalized monitoring and evaluation of student progress and learning can be challenging despite all the modifications. Indeed, despite the action plans, the latest challenge resolved was the *attention to students thinking*, which led to a substantial reduction in *communication*, *classroom management*, and *lesson plan design* challenges. Therefore, it is necessary to make adaptations that increase *classroom management* success by providing opportunities for group work and individual focus. The concrete materials employed in this study significantly reduced the challenges by supporting group work and individual progress. This enabled *attending to students thinking* and misconceptions. The visuality, symbolic language and abstract structure (Aktaş & Argün, 2020, 2021a; Erhardt & Shuman, 2015; Figueiras & Arcavi, 2014; Godfrey & Loots, 2015; Phelan, 1969), which may pose problems for individuals with visual impairment due to the nature of mathematics, became accessible. However, it is essential to master the students' pre-knowledge and the qualities of the material. In addition, technological tools are highly useful for designing and analyzing written documents (Effendi et al., 2021; Juhász, 2011). Consequently, an individual's professional competence is not dependent on their physical qualifications (Effendi et al., 2021). Instead, individuals should interpret professional competencies based on their own abilities and qualities.

While the results of this study provide strong insights, it is important to consider the limitations inherent in working with a single pre-service teacher. So, although the fact that the present study was conducted with a single pre-service mathematics teacher with low vision may seem to be a limitation, the strong results of the action research provided an opportunity to interpret the professional requirements. Accordingly, by identifying the barriers to analyzing student thinking, whether oral or written, and including adaptations and support tools, effective teaching of mathematics to sighted students can be achieved

without any barriers by teachers with low vision. Identifying the needs of pre-service mathematics teachers with low vision by discerning the themes obtained in the present study can provide them with professional competence in line with the proposed solutions. Ultimately, it is inevitable that they will become teachers who can identify their individual difficulties and produce solutions in the future (see Ingersoll & Strong, 2011; Onafowora, 2005). In addition, it was concluded that mathematical concepts are significant in the design of materials and lesson plans. This result will contribute to examining the challenges arising from the nature of mathematical concepts (see Aktaş & Argün, 2020) in the context of visual impairment and providing solutions for material selection and lesson plan design. Current research on visual, mathematical content is limited to tables and triangles. Identifying the challenges of symbolic language and visual elements reflected in teaching practices is also a noteworthy gap for future research. Indeed, symbolic language and visual elements pose problems and difficulties for individuals with visual impairment (see Aktaş & Argün, 2020, 2021a).

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GENİŞ ÖZET

Amaç

Görme engelli öğretmen adaylarının yükseköğretimdeki deneyimlerini geliştirmek ve yükseköğretim kurumlarına eşit erişim sağlayacak yeni politikaları teşvik etmek için öğretmen yetiştirme programındaki deneyimlerinin anlaşılmasına ihtiyaç vardır. Bu nedenle araştırmanın amacı az gören bir matematik öğretmen adayının öğretim uygulamalarında karşılaştığı güçlükleri belirlemek ve bunlar için üretilen çözüm önerilerinin etkililiğini değerlendirmektir. Buna göre araştırma problemleri şöyledir:

1. Az gören matematik öğretmen adayının öğretmenlik uygulamalarında karşılaştığı güçlükler nelerdir?

2. Az gören matematik öğretmen adayının öğretmenlik uygulamasında karşılaştığı güçlüklere ilişkin olası çözüm önerilerinin sonuçları nasıldır?

Yöntem

Araştırmacının eğitim fakültesinde az gören öğretmen adayları öğretmenlik uygulaması sürecinde çeşitli sorunlarla karşılaşmıştır. Bu sorunları 'özel eğitim ve kaynaştırma' ve 'öğretmenlik uygulaması' derslerini sunan araştırmacıya iletmişlerdir. Amaç ve problemin ortaya çıkış sürecinden dolayı araştırma iş birliği odaklı (işbirlikçi) eylem araştırması olarak tasarlanmıştır. Bu bağlamda üç eylem planı hazırlanmıştır. Güçlüklerin belirlenmesi, hedefler ve planlama, eylem planını uygulama ve müdahaleyi değerlendirme basamakları takip edilmiştir. Öğretmen adayı (Yıldız) sınıf uygulamalarını gerçekleştirdikten sonra güçlükleri belirlemiştir. Ayrıca, video kayıtlarıyla araştırmacı da gözlem yapmıştır. Yıldız'ın tasarladığı uygulamalar araştırmacıyla birlikte inceleyerek hedefler belirlenmiş ve çözüm önerileri tartışılmıştır. Eylem planının uygulanmasında, Yıldız tasarlanan ders planını yürütmüş ve dersini video kaydına almıştır. Son basamakta ise uygulanan çözüm önerisinin işlevselliği ve etkililiği değerlendirilmiştir ve yeni eylem planının gerekliliği tartışılmıştır.

Amaçlı örnekleme metodu ile belirlenen katılımcı matematik öğretmen adayı Yıldız eğitim fakültesi son sınıf öğrencisiydi. Doğuştan az gören katılımcı eğitim hayatını kaynaştırma sınıflarında tamamlamıştır. 16 punto metin okuyabilmekteydi. Nadiren gözlük kullanmayı tercih etmekteydi. Sınavlarda okuyucu desteğine de ihtiyaç duyabiliyordu. Eylem araştırması süresince Yıldız sınıf uygulamalarını (8.sınıf) tek başına yürütmüştür.

Veriler haftalık görüşmeler ve video kayıtları yoluyla toplanmıştır. Yıldız'ın tasarladığı ders planları ve uygulamalardaki gözlemlerinin analizleri görüşmelerin içeriğini oluşturmuştur. Bunun için 'uygulamada yaşadığın güçlük neydi?' ve 'planında herhangi bir yetersizlik belirledin mi?' benzeri sorular sorulmuştur. Veriler transkript edildikten sonra süregelen analizler gerçekleştirilmiştir. Her bir eylem planının sonunda ve eylem araştırması tamamlandıktan sonra geriye dönük analizlerle genel değerlendirme gerçekleştirilmiştir. Güçlüklerin tespitinde içerik analizi metodundan yararlanılmıştır.

Bulgular

İlk eylem planında güçlükler 'iletişim' ve 'sınıf yönetimi' olarak belirlenmiştir. İletişim, öğrencilerle iletişimi başlatma ve söz hakkı verme kategorilerini içermektedir. Sınıf yönetimi, sınıfa hitap etmeyi ve öğrencilerin tümünü gözlemleyebilmeyi içermektedir. Yıldız'ın el kaldıran öğrenciler arasında seçim yaparken kıyafet renklerine göre veya öğrencinin yanına giderek öğrencilere hitap etmesi hedefler olarak belirlenmiştir. Sınıf hâkimiyeti için sürekli sıraların arasında gezinmesi gerekmiştir. Her öğrenci ile göz kontağı kurmaya çabalamıştır.

İlk eylem planında 'iletişim' güçlüğü önemli ölçüde çözüme kavuşurken 'sınıf yönetiminde' sorunların devam ettiği belirlenmiştir. Yıldız öğrencilerin defterlerindeki çözümleri kontrol etmekte güçlük yaşamıştır. 'Sınıf yönetimi' teması altında öğrencileri takip etme, defterlerdeki ve tahtadaki yazıları kontrol etme kategorileri güçlük olarak belirlenmiştir. Öğrencilerin kendi aralarında konuşmalarını engellemek, derse katılımını ve Yıldız'ın hâkimiyetini artırmak için güçlüğün 'ders planı tasarımı' olduğuna karar verilmiştir. Yıldız ile bir ders tasarımı oluşturulmuştur. Böylece, grup çalışmasının 'iletişim' ve 'sınıf yönetimi' için etkili bir çözüm önerisi olduğu belirlenmiştir. Ancak, yeni bir güçlük olarak 'öğrenci düşünmesine dikkat etme' ortaya çıkmıştır. Yıldız, öğrencilerin defterlerini göremediği için cevapları dikkate alması mümkün olmamıştır. Bu güçlüğü bertaraf eden somut materyal kullanımı olmuştur. Büyük punto metinler, tablo kullanımı ve küçük grupların oluşturulması Yıldız'ın öğrencilerin ilerleyişini kontrol etmesini kolaylaştırmıştır.

Sonuçlar ve Tartışma

Az gören matematik öğretmen adayı için sınıf uygulaması güçlükleri iletişim, sınıf yönetimi, ders planı tasarımı ve öğrenci düşünmelerine dikkattir. Temalar görme yetersizliğinden kaynaklandığından her bir güçlük bir diğeriyle ilintilidir. Öğrencilerle göz teması kurmakta güçlük yaşanması iletişimi olumsuz etkilediğinden sınıf yönetimi de güçleşmektedir. Dolayısıyla, ders planında uygulamayı kolaylaştıracak destek eğitim materyallerine ve öğretim stratejilerine yer verilmesi gerekmektedir. İletişimin artmasıyla ve sınıf yönetiminin sağlanmasıyla öğrenci düşünmelerine odaklanma artmaktadır. Sınıfın kalabalık olması ve uzun banklar farklı çalışmaları kısıtlamaktadır. Dolayısıyla, yetersizliği ortaya çıkaran engellerin çözüme kavuşturulması için mesleki ve fiziksel donanımlar bir arada ele alınmalıdır. En son çözüme kavuşan ve iletişim, sınıf yönetimi ve ders planı tasarımı güçlüklerini önemli ölçüde ortadan kaldıran öğrenci düşünmelerine dikkattir. Bu nedenle grup çalışmasıyla sınıf yönetimindeki başarıyı artıracak ve bireysel odaklanmayı sağlayacak uyarlamalar gereklidir. Şimdiki araştırmada yararlanılan somut materyaller, grup çalışması ve bireysel ilerlemeyi destekleyerek güçlükleri ortadan kaldırmada başarılı olmuştur. Dolayısıyla, mesleki yeterlilik bireyin fiziksel nitelikleriyle ilgili değildir. Aksine, bireyin kendi niteliklerine uygun olarak mesleki yeterlikleri yorumlaması önemlidir.

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Contribution of Researchers

The research was conducted by the author.

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Conflict of Interest

The researchers do not have any personal or financial conflicts of interest with other individuals or institutions related to the research.

Ethics Committee Declaration

This study was carried out with the approval and under the scrutiny of the Ethics Committee of Kahramanmaras Sutcu Imam University (E-72321963-605.99-23560) and complied with the rules of research ethics imposed by the Council of Higher Education. The author declares that there is no conflict of interest (Document date: 24.03.2021, Document number: 2776).