Designing a Mathematical Modeling Activity for Students with Mild Intellectual Disabilities: Google Maps Example*

RESEARCH ARTICLE

Ahmet GÖK[1], Ayşen KARAMETE[2]

1 Teacher, MEB, Ministry of National Education, agok43@hotmail.com. 0000-0003-4457-5597

2 Assoc. Prof. Dr., Balıkesir University, Necatibey Faculty of Education, karamete@balikesir.edu.tr. 0000-0001-8442-2080

Gönderilme Tarihi: 22.12.2024 Kabul Tarihi: 18.03.2025 DOI: 10.37669/milliegitim.1605632

Citation: "Gök, A., & Karamete, A. (2025). Designing a mathematical modeling activity for students with mild intellectual disabilities: Google maps example. *Milli Eğitim, 54*(246), sayfa 959-996. DOI:10.37669/milliegitim.1605632"

Abstract

In order to address real-world problems, various solution methods are adapted to meet the needs of students at different levels. This study aims to design a Google Maps activity within the "Length and Measurement" learning domain for students with mild intellectual disabilities, aligned with model-eliciting activities. The research was conducted using the design and development research method. The Google Maps activity designed was developed using the ADDIE instructional design model. In the analysis phase, the activity, connected to real-world contexts, was designed in collaboration with special education teachers and subject matter experts. During the design and development phases, it was decided to frame the Google Maps activity by examining the components of modeling activities and the support education program published by the General Directorate of Special Education and Guidance Services. Aligned with the principles of model-eliciting activities, the activity was structured into components, including an introduction phase, warm-up, a problem situation, and a presentation of solutions. Additionally, following the expert evaluation of two special education teachers, the activity was adapted to suit students with mild intellectual disabilities. During the implementation phase, the activities were carried out with three high school students with mild intellectual disabilities. To ensure reliability, the students' responses were evaluated by two field experts during the analysis process. Based on the findings, it can be concluded that the Google Maps activity, designed as a real-world problem-solving task for students with mild intellectual disabilities, is well-suited to the framework of model-eliciting activities.

Keywords: *students with mild intellectual disabilities, mathematical modeling, design and development research, instructional design, ADDIE model.*

*This study is based on the first author's PhD dissertation conducted at Balıkesir University under the supervision of the second author.

Hafif Düzeyde Zihinsel Yetersizliği Olan Öğrencilere Yönelik Matematiksel Modelleme Etkinliği Geliştirilmesi: Google Haritalar Örneği

ARAŞTIRMA MAKALESİ

Öz

Gerçek dünyada karşılaştığımız problemleri çözmek için her düzeyden öğrenciye gereksinimlerine uygun olacak şekilde çeşitli çözüm yöntemleri kullanılmaktadır. Bu çalışmanın amacı, hafif düzeyde zihinsel yetersizliğe sahip kaynaştırma öğrencilerine yönelik "Uzunluk ve Ölçme" öğrenme alanına ait Google Haritalar etkinliğini model oluşturma etkinliklerine uygun olarak tasarlamaktır. Araştırma, tasarım ve geliştirme araştırması yöntemi ile gerçekleştirilmiştir. Hafif düzeyde zihinsel yetersizliği olan öğrencilere yönelik Google Haritalar etkinliği ADDIE öğretim tasarım modeli çerçevesinde oluşturulmuştur. Analiz basamağında, öğretim sürecinde gerçek dünya ile ilişkilendirilen etkinlik, özel eğitim öğretmenleri ve konu alanı uzmanlarıyla iş birliği içinde tasarlanmıştır. Tasarım ve geliştirme basamaklarında model oluşturma etkinlikleri bileşenleri ile Özel Eğitim ve Rehberlik Hizmetleri Genel Müdürlüğü tarafından yayınlanan destek eğitim programı incelenerek, ölçme öğrenme alanı çerçevesinde Google haritalar etkinliğinin tasarlanmasına karar verilmiştir. Model oluşturma etkinlikleri bağlamında giriş, hazır oluş soruları, problem durumu ve çözümlerin sunumu bileşenleri ile etkinlik oluşturulmuştur. Ayrıca iki özel öğretim öğretmeninin uzman değerlendirmesi sonucunda hafif düzeyde zihinsel yetersizliği olan öğrencilere uygun hale getirilmiştir. Uygulama basamağında, etkinlikler hafif düzeyde zihinsel yetersizliğe sahip üç lise öğrencisiyle uygulanmıştır. Güvenirliğinin sağlanması için; öğrencilerden alınan cevaplar değerlendirme sürecinde, iki alan uzmanı tarafından kontrol edilmiştir. Araştırmada katılımcıların etkinliğe verdiği cevaplar, araştırmacı tarafından geliştirilen model oluşturma etkinlikleri değerlendirme formu kullanılarak ve uygulama esnasında tutulan saha notları ile değerlendirilmiştir. Hafif düzeyde zihinsel yetersizliği olan öğrencilerin Google haritalar etkinliğine verdiği cevapların model oluşturma etkinlikleri bileşenlerine uygunluğunun yeterli düzeyde olduğu sonucuna varılmıştır. Araştırmanın bulguları hakkında hafif düzeyde zihinsel yetersizliği olan öğrencilerin gerçek dünya problemi olan Google haritalar etkinliğinin model oluşturma etkinlikleri bileşenlerine uygun olduğu sonucuna ulaşılabilir.

Anahtar sözcükler: *hafif düzeyde zihinsel yetersizliği olan öğrenciler, matematiksel modelleme, tasarım ve geliştirme araştırması, öğretim tasarımı, ADDIE model*

Introduction

The world we live in offers numerous opportunities but also presents significant challenges. Beyond solving these challenges, developing effective solution methods has been a key focus for mathematics educators. In this context, mathematical modeling provides a valuable approach by enabling the creation of problems rooted in real-world processes and presented through contextual texts. Many researchers define mathematical modeling as a process of transferring real-life problems into the realm of mathematics and analyzing them using mathematical methods (Borromeo Ferri, 2006; Bukova Güzel, 2019; Maaß, 2006). Mathematical modeling problems play a critical role in fostering students' abilities to think critically, analytically, and creatively, while also enhancing their mathematical communication skills and offering alternative ways to solve real-world situations (English, 2006; English & Watters, 2004; English & Watters, 2005). Through mathematical modeling, students are expected to acquire the ability to effectively address real-life problems using mathematical concepts. These expectations are addressed as problem-solving skills involving real-life situations. Problem-solving, a fundamental mathematical skill, enables students to tackle real-world challenges by applying the knowledge and skills they gain through the mathematics curriculum (Bağlama, 2018). The ability of students to adapt learned concepts to real-world problems is embedded in curricula under the umbrella of problem-solving skills. The National Council of Teachers of Mathematics (NCTM) identifies problem-solving as one of the primary objectives of the mathematics curriculum (NCTM, 2000). Problem-solving is a crucial component that influences the mathematical thinking skills of all students, from preschool to higher education. For students with special needs, as well as those in general education, mathematical thinking skills hold particular significance (Karabulut & Yıkmış, 2016). Problem-solving, a subdomain of mathematics learning, is a skill that many students with special needs find particularly challenging (Montague & Applegate, 1993). Numerous studies on difficulties in the problem-solving process focus specifically on students with special needs (Montague & Applegate, 1993; Ostad & Sorensen, 2007; Özkubat & Özmen, 2018; Rosenzweig et al., 2011; Shin & Bryant, 2015; Swanson & Jerman, 2006). Mathematical modeling enhances students' problem-solving, critical, and creative thinking skills by enabling the analysis of real-world problems through mathematical methods. This skill is important for both general education students and those with special needs. However, it is emphasized that students with mild intellectual disabilities often face challenges in the problem-solving process, as highlighted by numerous studies. This situation underscores the need for this study, given the limited availability of activities aimed at developing mathematical thinking and problem-solving skills for these students and the inability of the current mathematics curriculum to fully address their individual needs.

Students with Mild Intellectual Disabilities

Addressing the problem-solving challenges of students with mild intellectual disabilities requires understanding their specific learning needs and providing appropriate educational support. Students with physical, emotional, and cognitive differences require special education support due to their unique characteristics. Educating these students in the same environment as their peers in general education is referred to as inclusive practice (Kırcaali-İftar, 1998). According to the Regulation on Special Education Services, inclusive practice is defined as "education provided full-time or part-time in special education classrooms with peers, supported by educational services to promote interaction and help individuals with special needs achieve their educational goals effectively across various learning environments" (Ministry of National Education [MoNE], 2018, p. 2). Although students with special education needs are expected to share the same classroom with their peers during the inclusive practice process, they are not required to follow the exact same educational program. Instead, they are provided with an Individualized Education Program, which is defined as "a special education program designed to achieve targeted goals in line with the developmental characteristics, educational needs, and performance levels of individuals with special education needs, including support services tailored to them" (MoNE, 2018, p. 1). In our country, individuals with intellectual disabilities are defined as those who score two standard deviations below the average in terms of intellectual functioning, exhibit deficiencies or limitations in conceptual, social, and practical adaptive skills, display these characteristics during the developmental period before the age of 18, and require special education and support services (MoNE, 2010). These individuals, typically with IQ scores between 50 and 70, are categorized as having mild intellectual disabilities and are often referred to as educable. Compared to their peers, students with mild intellectual disabilities tend to have shorter and more scattered attention spans, limited vocabulary, delays in acquiring reading and writing skills, and a tendency to forget information quickly (Başal & Batu, 2002; Gönener et al., 2010; Güven, 2008; MoNE, 2010). Educational programs designed for the general student population often assume a certain level of intellectual capacity (Scruggs & Mastropieri, 1993). As a result, students with intellectual disabilities may not fully benefit from such programs (Hohalan et al., 1994; Parmar & Cawley, 1993). These students require additional time, individualized attention, and tailored resources to succeed. To address their needs, an adapted version of the standard curriculum should be provided, along with a well-structured Individualized Education Program that considers their academic, emotional, and intellectual capacities (Mete et al., 2017; Öner, 2018). Despite these differences, students with intellectual disabilities are not fundamentally different from their peers in their emotional needs. They desire love, affection, and opportunities for success in areas such as reading and writing, just like any other student. Understanding the specific needs of these students is essential for creating supportive educational environments and meeting their unique requirements (Eripek, 2003; Özsoy et al., 2001; Sucuoğlu & Kargın, 2010). The most apparent difference between these students and their typically developing peers is their delayed mental development and cognitive functioning, which becomes more noticeable when compared to others (Sezgin, 2016). They face challenges in learning academic concepts, often learning later and to a more limited extent. They may struggle with short attention spans, poor memory, difficulty understanding abstract concepts, and challenges in adapting to new situations. To improve learning retention, instruction should be conducted at different times, in various environments, and using diverse methods (Eripek, 2003; Özsoy et al., 2001; Sucuoğlu & Kargın, 2010).

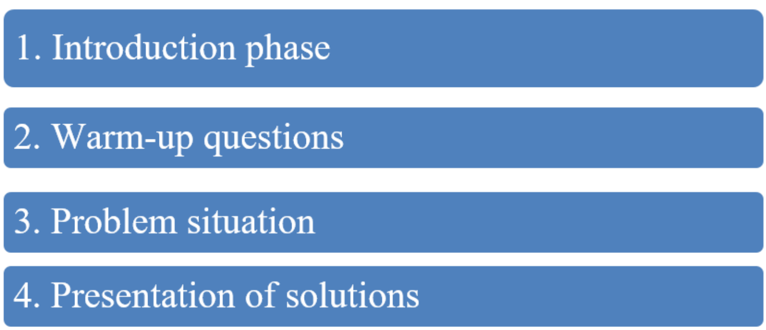
Model Eliciting Activities

Teaching real-world problems through activities is predicted to support the retention of learning. In this context, Kuş and Gökbulut (2021) highlighted that while most classroom teachers adopted the use of various materials and activities in teaching mathematics to inclusive students, a minority believed that the mathematics curriculum outcomes were not suitable for these students. Consequently, the concept of activity emerges as a significant element in mathematics education. An activity is implemented as a process encompassing multiple stages, such as capturing interest, exploring, explaining, deepening understanding, and evaluating. These activities can span an entire lesson, focus on solving a single problem, or involve completing a specific task (Gürbüz & Doğan, 2019). Considering the advancements in technology and changing environmental conditions, activity-based learning environments are expected to hold a prominent role in today's education systems. According to Lesh and Doerr (2003), within this framework, Model-Eliciting Activities (MEAs) have gained prominence as a critical tool to foster students' creative potential, enhance analytical thinking, and address real-world problems. MEAs are defined as problem-solving activities in which learners apply mathematical modeling to tackle challenging real-world problems, construct models to find solutions, test these models, refine them as necessary, and present their results (Eric, 2008). Unlike traditional approaches that rely on predetermined formulas or known methods, these activities empower learners to develop their own mathematical models tailored to real-world problem scenarios (Chamberlin & Moon, 2008; Lesh & Zawojewski, 2007). According to Lesh et al. (2000), MEAs are not only effective tools for fostering students' understanding but also valuable in assessment processes and research aimed at eliciting learners' ideas. For this reason, MEAs are considered highly beneficial for teachers, as they help students articulate and comprehend their thought processes. Transforming lesson plan activities into MEAs could, therefore, significantly enhance teachers' ability to facilitate learning and improve student outcomes (Lesh et al., 2010).

When preparing Model Eliciting Activities (MEAs), there are specific components applied in a sequential manner. These components are the introduction phase, warm-up questions, the problem situation, and the presentation of solutions, each constituting the fundamental structure of MEAs (Figure 1) (Chamberlin & Chamberlin, 2001; Chamberlin & Moon, 2005, 2008; Yu & Chang, 2009).

Figure 1

Four fundamental Components of Model Eliciting Activities



The first two components, the introduction phase and warm-up questions, aim to introduce and prepare learners for the context of the problem prior to engaging with the problem situation (Chamberlin & Chamberlin, 2001;

Yu & Chang, 2009). These components can be considered as the warm-up phase, equipping learners with foundational understanding before addressing the central problem. The problem situation, recognized as the core component of MEAs, represents the third essential element (Yu & Chang, 2009). This component involves a scenario where working groups of learners develop one or more models to address and solve an existing problem (Chamberlin & Moon, 2005). Finally, the presentation of solutions is the phase where learners share the solutions derived from the models they created in collaboration with their working groups. This is presented to their classmates as part of the learning process (Chamberlin & Chamberlin, 2001). In line with the processes of these four foundational components, the implementation of MEA practices serves two primary purposes. The first is to enable mathematics educators to investigate learners' model development processes (Lesh et al., 2000). The second is to uncover unrecognized mathematical abilities of learners during the assessment phase of implementation (Chamberlin & Moon, 2005; Lesh et al., 2000).

Considering the characteristics of students with mild intellectual disabilities, teacher interventions that guide them during the teaching process are considered essential. Bağlama (2018) emphasizes that students with intellectual disabilities can benefit from teacher guidance during skill management and instructional practices. Therefore, there is a significant need for teaching methods that can effectively guide students with mild intellectual disabilities through problem-solving processes and intervene when necessary during instructional activities. In this context, the development and implementation of mathematical modeling activities are believed to address this need effectively. Teacher interventions play a crucial role in guiding student work during modeling practices (Bukova Güzel, 2019). These interventions can be structured by posing guiding questions for each stage of the modeling activities, helping students navigate the components of the process. Hence, it is crucial for teachers to consider adopting model-eliciting activities within mathematical modeling practices to support the learning of students with mild intellectual disabilities.

In the context of solving real-world problems, the contribution of MEAs is significant in helping students with mild intellectual disabilities adapt to mathematics instruction. The models created through MEAs are recognized as problem-solving activities designed to explain, test, organize, and refine mathematical ideas. This study aims to design a Google Maps activity for inclusion students with mild intellectual disabilities in the "Length and Measurement" learning domain, within the framework of the ADDIE instructional design model and aligned with the components of MEAs. To achieve this goal, the activity will be developed and refined based on expert input, and the participants from the target group will complete the activity under the guidance of the researcher, who also acts as the course instructor. During implementation, participants are expected to experience the MEA components, including the introduction phase, warm-up questions, problem situation, and presentation of solutions.

Methodology

This section provides detailed explanations regarding the research methods and design employed in the study, the research group, the process of designing the modeling activity, data collection tools, data analysis procedures, and the validity and reliability of the research.

Research Model

This study aims to design a Model Eliciting Activity (MEA) tailored for students with mild intellectual disabilities and to assess its alignment with MEA components by implementing it in special education classrooms. To achieve this objective, the study adopted the Design and Development Research (DDR) method, initially referred to as developmental research (Richey, 1994; Richey & Klein, 2005) and later defined as design and development research (Richey & Klein, 2008, 2014). This method is categorized into two main types: Type-1, which focuses on product and tool research, and Type-2, which focuses on model research. In line with the study's objective, Type-1 Development Research was employed within the DDR framework. This type of DDR is a research approach focused on the development of new products and tools (Richey & Klein, 2008). In such studies, it is not only the development of the product that is emphasized, but also the evaluation of its applicability from various perspectives (Richey & Klein, 2014). According to Richey & Klein (2008), DDR involves systematic design, development, and evaluation processes grounded in scientific evidence to create products, tools, or new development models for both instructional and non-instructional purposes. The design of the MEA in this study adhered to the stages of the ADDIE instructional design model (Büyüköztürk et al., 2018). Data collected during the research process were systematically organized and analyzed using the descriptive analysis technique, and the findings were subsequently presented. In descriptive analysis, data are coded according to predefined themes identified in the literature (Yıldırım & Şimşek, 2006).

Research Group

Criterion sampling, a purposive sampling method, was used to select participants based on predefined qualifications (Büyüköztürk et al., 2018). The criterion was that students had to be diagnosed with mild intellectual disabilities. The participants were three male 12th-grade high school students (S1, S2, S3) from a district in the Aegean region, characterized by families of middle socioeconomic status. Diagnosed by the Guidance and Research Center, all students were in full-time inclusive education.

S1 (17 years old) can read and write but is shy and easily excited in lessons. S2 (18 years old) is sociable, contributes to discussions, and has reading and writing skills. S3 (17 years old) reads and writes but avoids initiating communication, responding only when addressed. All students could perform basic arithmetic and relate kilometers to meters.

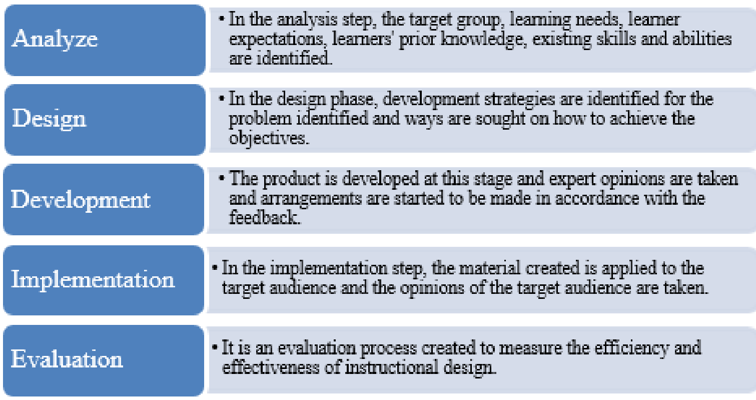
Ethical permissions were obtained from the relevant ethics committee and the Directorate of National Education. The study was conducted in a high school where the school administrators, subject teachers, and school counselors participated voluntarily, providing a supportive environment for the research.

Process and Implementation

In this study, the activity was developed within the framework of the ADDIE instructional design model. The ADDIE model derives its name from the initials of words analysis, design, development, implementation, and evaluation. A brief description of the ADDIE steps is provided in Figure 2 (Yiğit, 2012; Şimşek,2013):

Figure 2

ADDIE Instructional Design Model



During the evaluation phase of the MEA design process, the compatibility of the designed activity with the components of the MEA was examined. To assess the activity developed in this process, observation notes, activity sheets, and audio recordings were utilized. The specific tasks performed at each stage during the design of the Google Maps activity are detailed below.

Analysis: Students with mild intellectual disabilities, despite their low academic levels, need to solve real-world problems to meet daily needs. The identification process began with interviews at the Guidance and Research Center (GRC), where students and their schools were determined in collaboration with experts. Further interviews with school counselors and teachers provided detailed academic and behavioral insights. Participants were selected voluntarily with the approval of administrators, teachers, and parents.

Before designing the activity, a preliminary interview was conducted with students during inclusive education. In this session, challenges faced by students were discussed, revealing that S1 worked at a pita shop and used Google Maps for finding addresses. This led to the decision to design a Google Maps activity focusing on measuring length. Yılmaz (2020) highlighted maps as tools for online mathematics education, with pre-service teachers identifying measuring length as a suitable concept.

Recognizing that students with mild intellectual disabilities often face difficulties with abstract and complex mathematical skills (Bouck & Flanagan, 2009; Kroesbergen & Van Luit, 2003), instructional techniques were used to break problems into manageable parts. Warm-up levels were assessed through Individualized Education Program plans, with an evaluation form identifying current abilities and long-term goals. The selected students could read fluently and perform arithmetic operations, including four-digit addition and subtraction with regrouping. The activity was developed and implemented based on their prior knowledge and mathematical abilities.

Design and development: The objective of this study was to enable students with mild intellectual disabilities to solve a Model-Eliciting Activity (MEA) addressing length measurement within the measurement subdomain. MEAs were selected for their structured approach, comprising an introduction phase, problem situation, and solution presentation (Chamberlin & Chamberlin, 2001; Yu & Chang, 2009). The introduction phase incorporated visuals, videos, and applications to familiarize students with the problem context, as research highlights the positive impact of such tools on students with mild intellectual disabilities (Krouse, 2001).

The Google Maps activity was developed to teach length measurement through real-world scenarios involving the four basic arithmetic operations and unit conversions. The activity aligned with the mathematics curriculum objectives, such as solving multi-step problems and converting between units like kilometers and meters. The design process involved consulting two special education experts, who emphasized clarity, simplicity, and the use of concrete visuals. These recommendations were applied to activity sheets, which included problem texts on the front and evaluation questions on the back. The implementation environment included interactive boards, WhatsApp for resource sharing, and Zoom for video preparation.

The activity followed four MEA components. In the introduction phase, students watched a Google Maps tutorial video explaining how to calculate distances. For homework, they determined the distance between their homes and school using Google Maps, recording their answers on paper to bring to class. The warm-up phase involved four questions about calculating distances and unit relationships, such as meters to kilometers.

The problem scenario introduced Ms. Zeynep, who navigated various routes during her daily travels, covering specific distances represented visually on Google Maps. Students were tasked with identifying the shortest route she could take. In the solution phase, they identified key facts, developed and compared models, and solved a similar problem using the same methodology. This scaffolded approach ensured accessibility for students with mild intellectual disabilities, breaking the problem into manageable parts.

Before implementation, trial applications were conducted with a middle school student possessing similar skill levels to identify potential issues. Feedback from a mathematical modeling expert led to redesigning the activity as a contextual MEA, ensuring alignment with the target audience's needs. Finally, a specialist in Computer Education and Instructional Technology reviewed the design, and the activity was finalized for implementation.

Implementation and evaluation: According to Büyüköztürk et al. (2018), during this stage of the ADDIE model, the developed product is implemented for its intended purpose, and data are collected using scientific data collection tools to evaluate the product's impact and efficiency. For this study, the activity was conducted within the framework of inclusive practice with three students with mild intellectual disabilities in a district of the Aegean region. The support education room served as the classroom, an interactive whiteboard was utilized as instructional material, and a social media tool was employed for communication purposes. Given the characteristics of students with mild intellectual disabilities, teacher interventions to guide them during the teaching process were deemed essential. During the implementation, the activity was carried out under the teacher's guidance. For each question and task, the researcher posed guiding questions to direct students toward the correct answers. In the introduction phase, students were asked about the content of the video shared via social media and what they learned to accomplish the assigned task. The video utilized visuals extensively to facilitate understanding. In the warm-up questions phase, students were asked about the distance between their homes and school as well as their experiences using Google Maps. Additional guiding questions included inquiries about their understanding of kilometers and meters and the relationship between these units. Care was taken to ensure the clarity and simplicity of the questions posed during this phase. In the problem situation phase, the problem text was read multiple times with the students under the teacher's guidance. The teacher clarified any confusing aspects of the visuals and text. Because students with mild intellectual disabilities struggled to conceptualize assumptions and models, the assumptions of the problem were rephrased using the word "situations" and the models they created were simplified accordingly. Guiding questions were used to clarify what was given and what was being asked, how many situations were present, and what those situations were. For the mathematical solution and comparison of models, students were asked how the determined situations were solved mathematically and how the results were compared. This approach aimed to make abstract questions more concrete using guiding questions. In the presentation of solutions phase, students were asked guiding questions about any mistakes in the solutions provided and whether they had alternative solution suggestions. Additionally, to assess their ability to apply the modeling process to other problems, students were asked to solve a different question related to the same problem and describe their approach. During the implementation, the activity was jointly carried out by the students and the researcher. Students answered only the questions directly related to the problem text. Audio recordings were taken, observation notes were maintained, and activity sheets were distributed throughout the process.

According to Büyüköztürk et al. (2018), in the evaluation phase, in the light of the data collected during the implementation, the overall impact of the research conducted, the contribution it brings, the strengths of the product, and the aspects that need to be developed should be revealed from beginning to end. For this reason, the findings and results of the data collected in order to provide evidence of the appropriateness of the Google maps activity developed for students with mild intellectual disabilities to the MEA components should be presented. In this framework, two stages were followed for the formal evaluation of Google Maps effectiveness. In the first stage, expert opinion was taken and in the second stage, one-to-one application was made. As the first step, an activity evaluation form was prepared for the experts to assess the appropriateness of the Google maps activity to the MEA components. In the preparation of this form, 12 questions were first grouped under four main components. These are the introductory article, warm-up questions, problem situation and presentation of solutions, which are the basic components of model eliciting activities (Chamberlin & Chamberlin, 2001; Chamberlin & Moon, 2005; Chamberlin & Moon, 2008; Yu & Chang, 2009). In a similar study on model eliciting activities (Tekin Dede & Bukova Güzel, 2014), the components that should be considered in the process of designing activities were discussed. Accordingly, these components can be summarized as: familiarizing and preparing students with the context of the problem situation, developing models and comparing models as a result of mathematical solution, presenting solutions and providing an environment where students can revise solutions when necessary. The activity evaluation form prepared in line with these components was reviewed by an academician with 29 years of experience in Computer Education and Instructional Technology. In line with the opinion of the Computer and Instructional Technology Educator expert, four questions were reduced to eight questions by removing four questions because they contained similar expressions, and then one question in the introduction section was removed because it contained an obligation sentence for the student. In the final version, seven questions, one in the introduction section, two in the warm-up section, two in the problem situation section and two in the presentation of solutions section, were used as data collection tools (Table 1).

Table 1

MEA Evaluation Form

MEA Components	Questions	Suitable / Not Suitable
Introduction phase	How is the interest of students with mild intellectual disabilities in introductory videos or applications given as homework?	
Warm-up questions	How do students with mild intellectual disability comprehend the information about the content of the introduction?	
	How do students with mild intellectual disabilities generate and interpret new ideas about the context of the problem?	
Problem situation	What are the models that students with mild intellectual disabilities construct regarding the assumptions they form in the process of understanding the problem?	
	How do students with mild intellectual disabilities solve and compare the models they construct mathematically?	
Presentation of solutions	How do students with mild intellectual disabilities revise their mistakes and offer different solutions, if any?	
	How do students with mild intellectual disabilities apply the solution steps to other problems?	

Two mathematics educators evaluated the activity's alignment with MEA components using the MEA evaluation form, confirming its suitability. A special education expert suggested simplifying complex sentences for students with mild intellectual disabilities, and adjustments were made accordingly. Additionally, a Turkish Language and Literature teacher reviewed and corrected grammatical and punctuation errors. In the second stage, a one-to-one application was conducted with a middle school student using a finalized Google Maps activity. The researcher guided the student through the activity, addressing its appearance, usefulness, and clarity. Errors, including confusion in the problem statement about home-work distinctions, were corrected before implementation.

Data Collection Tools

The evaluation of the mathematical modeling activity designed for students with mild intellectual disabilities was carried out by assessing its alignment with the support education program and its suitability for the level outlined by the General Directorate of Special Education and Guidance Services. The activity was designed following the ADDIE instructional design model, incorporating the MEA components, and utilizing the Google Maps application within the sub-learning area of length measurement. It was also employed as a data collection tool. During the implementation phase, tools such as WhatsApp for social media communication and the ZOOM platform for distance learning were utilized to prepare videos. Additionally, audio recordings were taken, and field notes were meticulously maintained by the researcher.

Data Analysis

During the data analysis process, the alignment of the developed Google Maps activity with the MEA components was first assessed using the MEA evaluation form. Subsequently, the responses provided by students with mild intellectual disabilities to the activity were evaluated to ensure their reliability and consistency with the MEA components. The suitability of the Google Maps activity, designed based on model eliciting activity components, was analyzed using document analysis and descriptive analysis methods, in line with the criteria outlined for MEA components. Descriptive analysis involves summarizing and interpreting data based on themes identified in the existing literature (Yıldırım & Şimşek, 2006). In descriptive analysis that includes direct quotations, the primary goal is to effectively convey the perspectives of the interviewed or observed students. This approach ensures that interview and observation findings are presented to stakeholders in a well-structured and interpreted format. Data collection during the implementation phase involved the use of audio recordings, activity sheets, and observation notes. Audio recordings captured throughout the activity provided an additional layer of data for analysis and interpretation.

Validity and Reliability

Expert opinions were consulted to ensure the validity of the developed activity. Validity refers to the degree to which the intended concept is measured without interference from other unrelated factors (Karasar, 2009). To determine the agreement percentage regarding the MEA evaluation form subjected to document analysis, the consensus, disagreements, and analyses provided by the experts about the activity were evaluated. Coding was conducted by two mathematics education experts. The reliability coefficient (percentage of agreement) for the coding was calculated using the formula proposed by Miles & Huberman (1994): [agreement/(agreement + disagreement) x 100]. For instances where disagreement arose, the data were re-analyzed and discussed until a common decision was reached. According to Miles & Huberman (1994), the reliability of coding in qualitative studies should meet a minimum agreement rate of 80%. The analysis of the Google Maps activity, evaluated based on the MEA components through the MEA evaluation form, is presented in Table 2.

Table 2

Evaluation of Expert Opinions on the MEA

Study	Coders	Agreement	Disagreement	Agreement Rate (%)
MEA Evaluation	Two experts	14	2	88

As shown in Table 2, there were 14 agreements and 2 disagreements between the two mathematics education experts, resulting in an 88% agreement rate. The disagreements pertained to the question, “How do tasks designed for the support education room for students with special needs help warm up the student to the activity?” Specifically, the concerns were about the potential obligation for students and the hesitation of students with mild intellectual disabilities in providing responses. The experts noted that the remaining questions were structurally appropriate for interpreting similar problem situations. Consequently, it was agreed that the designed activity was suitable for implementation.

Findings

As a result of implementing the Google Maps activity designed for students with mild intellectual disabilities, under the guidance and teacher intervention provided by the researcher, who also served as the course teacher, findings were gathered. These findings include student responses categorized under the components of MEA: introduction phase, warm-up questions, problem situation, and presentation of solutions. The results for each component are presented in detail accordingly.

Findings Related to Introduction Phase

In this section, the findings regarding the responses to the guiding questions, "What did you learn from the video content?" and "Did you fulfill the given task?" are presented. These findings aim to assess whether the introductory videos and applications sent to the students effectively captured their attention and whether the tasks required to be brought to the support education room helped engage the students and prepare them for the activity.

An analysis of the students' activity sheets and field notes reveals that the Google Maps video was watched by students coded as S1, S2, and S3. The students' expressions of their thoughts about the video indicate that it successfully captured their interest. For instance, it is evident that the student coded S1 engaged with the introductory video, as reflected in their statement: "I work in a pita bakery on weekends. I find the addresses of the houses where we will deliver pita by using Google Maps." Similarly, the student coded S2 mentioned commuting daily from a village to school and noted that they could calculate the distance from their house in the village to the school. Lastly, the student coded S3 stated that although they had never used Google Maps before, they might consider using it in the future. These responses suggest that the video effectively piqued the students' interest and encouraged engagement.

It was observed that students coded as S1, S2, and S3 brought their homework task regarding the distance between home and school to the support education room. Their attempt to complete the table in the assignment by writing down the distance between home and school indicates that they were engaged and prepared for the activity.

Findings Related to Warm-up Questions

The first three of the four warm-up questions focus on understanding the information presented in the activity video from the introduction section, while the final question addresses student perspectives on the problem's context. This section presents the findings based on the responses to the guiding questions: "How can you find the distance between home and school?", "Can we find the distance between home and school with the odometer of a vehicle?", and "What is your experience with Google Maps?" These findings aim to assess the students' comprehension of the content introduced in the video. Additionally, the findings from the responses to the guiding question "What is the relationship between meters and kilometers?" are presented to explore new ideas about the problem's context and provide an interpretation of those ideas.

Examples of the responses provided by the students regarding their understanding of how to determine distances based on the video content are as follows: In response to the question, "How can we find the distance between home and school?", the student coded S3 stated, "I can count the distance between home and school by taking steps," but did not mention how to quantify or express the distance. The student coded S2 explained that counting the distance in steps would not be feasible due to living in a village far from the city. On the other hand, the student coded S1 did not provide any response to the question.

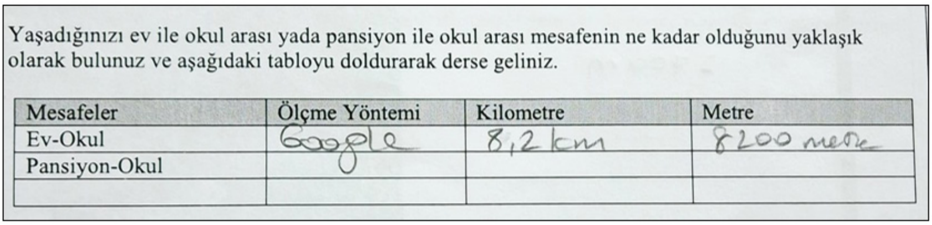
It was observed that the students coded S1, S2, and S3 were reluctant to answer the question, "Can we find the distance between home and school with the odometer of a vehicle?".

Examples of the answers provided by the students regarding their comprehension of the video content include the response to the question, "What is your experience with Google Maps?" The student coded S1 stated, "I work in a pita bakery on weekends. I find the addresses of the houses where we will take pita bread by using Google Maps."

In the final warm-up questions of the activity video, students were asked, "What is the relationship between meters and kilometers?" to elicit ideas about the context of the problem. The students' responses suggest that they were able to generate ideas related to the problem's context. For instance, the student coded S2 stated verbally that their home is in a village near the district and that they take a minibus every morning, traveling 8 kilometers to reach the school. This response indicates an understanding that distances can be measured in kilometers. Additionally, in the activity video within the introduction section, the student coded S2 also acknowledged that distances are measured in kilometers. The student coded S2 was further asked how they completed the table on the task sheet brought to the support education room. An example of the table filled out by the student coded S2 in the Google Maps activity, indicating the distance from their house to the school, is illustrated in Figure 3.

Figure 3

Distance Between Home and School Provided by Student Coded S2 Using Google Maps



Yaşadığınızı ev ile okul arası yada pansiyon ile okul arası mesafenin ne kadar olduğunu yaklaşık olarak bulunuz ve aşağıdaki tabloyu doldurarak derse geliniz.

Mesafeler	Ölçme Yöntemi	Kilometre	Metre
Ev-Okul	Google	8,2 km	8200 metre
Pansiyon-Okul			

The student explained how they completed the table with the following statement: "I watched the activity video. Using the video, I found that the distance between our house in the village and the school on Google Maps is 8.2 kilometers. When I converted it to meters with the help of Google, I found it to be 8200 meters." This response demonstrates the student's ability to use the information and tools provided in the activity to apply the concept of distance conversion.

Findings Related to the Problem Statement

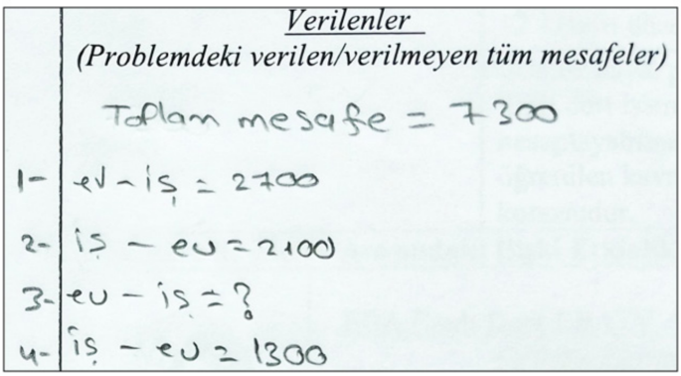
In this section, the findings are presented based on the responses to the guiding questions: "What are the givens of the problem?" for the assumptions made by the students during the problem comprehension process; "What are the situations that will lead to the solution of the problem?" for determining the mathematical solution of these models; "How many kilometers is the distance that Ms. Zeynep returns from home to work after eating lunch?" and "How many kilometers is the shortest distance when the situations are compared?" for analyzing and comparing the solutions provided by the students. These findings highlight the students' ability to identify key elements, create mathematical models, and compare solutions effectively.

The problem text of the Google Maps activity was read aloud with the students, and the researcher clarified any parts that were unclear. The students were instructed to write down their assumptions as the “givens” of the problem and their proposed models as “cases” on the activity sheet. During this part of the activity, the researcher offered guidance through explanations, but the students were responsible for developing and completing their own solutions to the problem.

Assumptions are expressed as the data provided without any analysis related to solving the problem. It was observed that students coded as S1, S2, and S3 wrote down the givens on the activity sheet. Upon analyzing the activity sheets, it was found that the students were able to create different situations based on the given data. Examples provided by the student coded S2 in the Google Maps activity regarding the problem are illustrated in Figure 4.

Figure 4

Givens (Assumptions) Provided by Student Coded S2 Related to the Problem

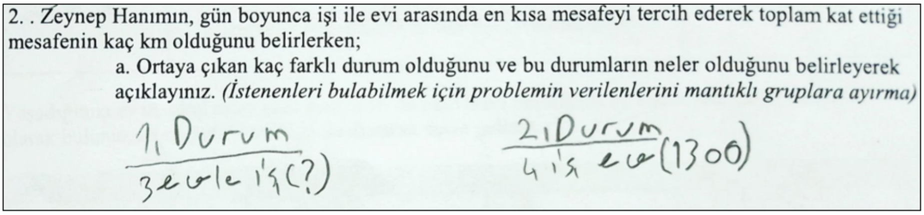


It was observed that the student coded S2 recorded Ms. Zeynep’s journey distances as follows: 2700 meters from home to work in the morning, 2100 meters from work to home before lunch, an unspecified distance from home to work after lunch, and finally 1300 meters from work to home in the evening. These distances were documented in four stages as part of the activity.

To determine the desired outcome, the assumptions, represented as the givens, are divided into logical groups, and models are constructed to facilitate the solution. Based on the provided data, Figure 5 illustrates an example from the student coded S1, demonstrating their approach to creating situations in the problem, specifically identifying which trip between home and work during the day involves the shortest distance.

Figure 5

Situations (Model) Created by Student Coded S1 Based on the Given (Assumption)



2. . Zeynep Hanımın, gün boyunca işi ile evi arasında en kısa mesafeyi tercih ederek toplam kat ettiği mesafenin kaç km olduğunu belirlerken;

a. Ortaya çıkan kaç farklı durum olduğunu ve bu durumların neler olduğunu belirleyerek açıklayınız. *(İstenenleri bulabilmek için problemin verilenlerini mantıklı gruplara ayırma)*

1, Durum
3 evle iş(?)

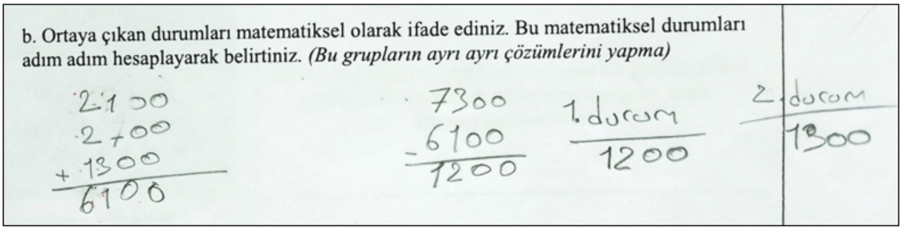
2, Durum
4 iş ev(1300)

The student coded S1 identifies two situations when creating models to determine which journey involves the shortest distance, based on the given data. The student explains that one situation involves traveling 1300 meters from work to home in the evening, while the other situation involves returning to work after lunch, though the exact distance for this trip is unknown.

In solving the problem in the Google Maps activity, students are expected to perform mathematical calculations for the situations they created. The instructions required students to first add the known distances to find the total and then determine the unknown distance by subtracting the total of the known distances from the total distance traveled during the day. Students who correctly followed these steps calculated the unknown distance as 1200 meters. Figure 6 provides an example of the mathematical solution by the student coded S3, demonstrating their calculation of the distance from home to work at lunchtime.

Figure 6

Mathematical Solution by Student Coded S3


b. Ortaya çıkan durumları matematiksel olarak ifade ediniz. Bu matematiksel durumları adım adım hesaplayarak belirtiniz. *(Bu grupların ayrı ayrı çözümlerini yapma)*

2100
2700
+ 1300
6100

7300
− 6100
1200

1. durum
1200

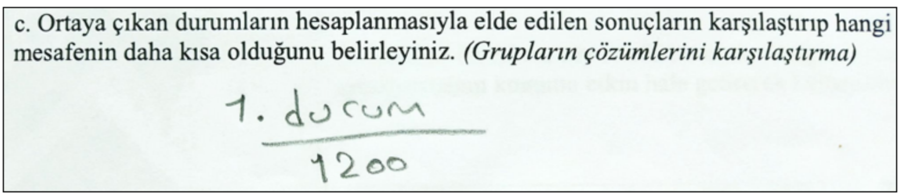
2. durum
1300

The student coded S3 identified the distance traveled from home to work at lunchtime as the result of subtracting the sum of the three given distances from the total distance traveled during the day.

By calculating the unknown distance for one of the two situations created by the students, the first situation was determined to be 1200 meters and the second situation 1300 meters. Upon comparing the cases, it was concluded that the shortest distance is 1200 meters, corresponding to the journey from work to home. Figure 7 provides an example of the comparison result from the student coded S3, illustrating their determination of the shortest distance among the journeys made by Ms. Zeynep during the day.

Figure 7

Comparison Result of Student Coded S3


c. Ortaya çıkan durumların hesaplanmasıyla elde edilen sonuçların karşılaştırıp hangi mesafenin daha kısa olduğunu belirleyiniz. *(Grupların çözümlerini karşılaştırma)*

1. durum
1200

The student coded S3 states that the shortest distance is 1200 meters, referring to the journey from home to work at lunchtime.

Findings Related to the Presentation of Solutions

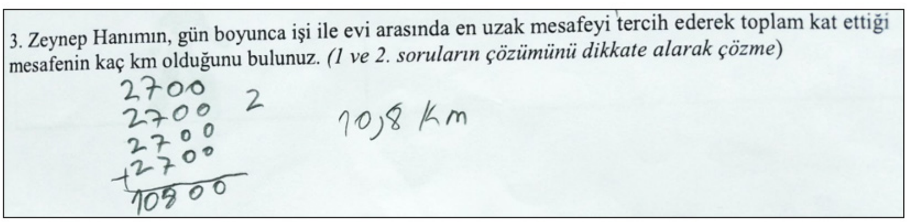
In this section, findings are based on the guiding questions: “Did you make a mistake in solving the problem? If so, how did you correct your mistake?” to encourage students to identify and revise their mistakes and suggest alternative solutions if applicable, and “How many kilometers would he/she travel in total if he/she preferred the farthest distance in all his/her trips throughout the day?” to evaluate the application of their solution methods to similar problems. These questions aim to assess students’ ability to critically analyze their solutions and extend their problem-solving strategies to new contexts.

At the end of the activity, the researcher addressed all questions related to the problem situation. Students were expected to review their solutions, revise any mistakes, and present them again. An analysis of the activity sheets revealed some errors. For instance, it was noted that the student coded S2 successfully created the situations correctly but made an error in adding four-digit numbers while calculating the unknown situation mathematically. This mistake affected the accuracy of the comparison between the situations. However, after receiving feedback about the mistake, the student recognized the error and revised their solution accordingly.

A new question was created based on the same problem situation, and students were asked to solve it by following the steps used in the original problem. The new question, derived from the Google Maps activity problem, was: “How many kilometers would he travel in total if he preferred the farthest distance in all his trips throughout the day?” The students who identified the farthest distance as 2700 meters for each trip and acknowledged that four trips were made during the day calculated the correct total distance. The solution provided by the student coded S1 is presented as an example in Figure 8.

Figure 8

Similar Problem Solution Provided by Student Coded S1



When the student coded S1 identified the farthest distance as 2700 meters, they calculated the result as 10,800 meters by adding four instances of 2700 for a total of four trips, including two arrivals and two departures. When converted to kilometers, this total distance corresponds to 10.8 kilometers for the day. The student was expected to follow the steps of the problem situation systematically: identifying the given information, determining the desired outcome, creating situations, performing calculations, and comparing the situations. However, it was observed that the student performed some of these steps mentally rather than explicitly documenting them.

Considering that a problem can have more than one solution method, when the students coded S1, S2, and S3 were asked if they had any alternative solution suggestions for this problem, all three stated that they did not have a different solution approach.

Discussions, Conclusions, and Suggestions

In this section, the results, discussions, and suggestions regarding the problem-solving processes of students with mild intellectual disabilities MEAs are presented. Additionally, students' opinions on the development of mathematical modeling activities designed for use in the teaching processes of students with mild intellectual disabilities are discussed.

The aim of this study is to examine the appropriateness of the Google Maps activity within the "Length and Measurement" learning domain to the components of Model Eliciting Activities (MEAs) for inclusion students with mild intellectual disabilities. Lesh et al. (2000) highlight that MEAs are effective not only in teaching and evaluation processes but also for research purposes. The findings of the study indicate that students with mild intellectual disabilities were able to effectively use the Google Maps activity, designed within the framework of MEA components, in teaching processes connected to real-world contexts. Additionally, it can be concluded that Google Maps is a valuable tool for measuring distances in mathematics education. Supporting this, pre-service mathematics teachers have suggested that Google Maps can be utilized for teaching length measurement in online education settings (Yılmaz, 2020).

When analyzing the findings related to the introduction phase section, the students' expressions of their opinions about the introductory video suggest that the videos successfully captured their attention. Furthermore, the realization that the distance between two locations is measured in kilometers indicates that the assignment helped the students engage with and warm up to the activity. These observations are supported by the following studies: Hart & Whalon (2012) conducted research where they aimed to teach animal groups to a high school student with autism spectrum disorder and intellectual disability using video-based self-modeling via a tablet. Additionally, Krouse (2001) highlighted that using appropriate videos related to the learning content in educational environments can yield positive results in the education of students with mild intellectual disabilities.

When the findings for the warm-up questions section are examined, it can be interpreted that the students were reluctant to answer the question "Can we find the distance between home and school with the odometer of a vehicle?", indicating that this method may not be useful for them. Additionally, the students' responses to the question "What is the relationship between meters and kilometers?" in the introduction section suggest that they were able to develop an understanding of the problem's context. To support these findings, the attitudes of students with mild intellectual disabilities towards understanding the introductory video, engaging with the problem context, and solving problems through MEAs are highlighted in the following statements. The purpose of the section comprising the introduction phase and warm-up questions is to warm-up the learners by introducing the problem situation, helping them prepare for the problem situation by becoming informed about its context (Chamberlin & Chamberlin, 2001; Yu & Chang, 2009). Additionally, it is emphasized that visuals can aid students with intellectual disabilities in mentally representing the problem, organizing numerical information, and understanding the narrative (Polo-Blanco et al., 2024).

When the findings for the problem situation section are examined, it can be interpreted that after reading and understanding the Google Maps problem, the students identified four different assumptions from the information they listed as given. Subsequently, they were able to create a model for solving the problem based on two distinct situations required by the problem. Furthermore, calculating the distance between home and work in the afternoon, which was not explicitly provided, can be interpreted as the mathematical determination of the unknown situation based on the presented scenarios and the comparison of the two situations using the results obtained. To support these findings, the following statements highlight the strategies used in MEAs for addressing the problem situation. In the problem situation component, students are asked to develop models (Chamberlin & Moon, 2005) and are expected to solve these models mathematically in detail (Chamberlin & Chamberlin, 2001). In this context, Özkubat (2019) emphasized that problem-solving skills can be developed in students with intellectual disabilities through a process-based approach by increasing the number of problem-solving strategies and incorporating them into problem-solving application steps.

When the findings regarding the presentation of the solutions are examined, it can be interpreted that the process of checking the solution to the problem, revising errors, and re-presenting the solution, if necessary, indicates that students are becoming aware of their mistakes and understanding how to correct them. Additionally, solving a different problem based on the same initial problem can be seen as evidence of the correct construction of models, the accuracy of mathematical solutions, and the effective comparison of models. To support these findings, the following statements highlight the role of MEAs in the presentation of solutions. The presentation of solutions component involves students sharing their solutions with their classmates (Chamberlin & Chamberlin, 2001). Furthermore, Polo-Blanco et al. (2024) state that solving problems with students with intellectual disabilities requires continuous interaction, encouraging them to engage with the problem, clarifying unfamiliar words, and addressing their mistakes during the process.

The literature supports the findings related to the responses of students with mild intellectual disabilities when solving real-world problems. For example, when an eighth-grade student with special needs was asked how real-world problems differed from other mathematics problems encountered in class, the student replied, "These questions change my perspective on the world" and "In class, we always study other people's mathematics, but here we have our own mathematics" (Goldman & Hasselbring, 1997). According to Goldman & Hasselbring (1997), standard textbook problems that typically appear at the end of chapters and are assigned as homework fail to provide students with mild intellectual disabilities an opportunity to understand how to apply mathematical knowledge to solve real-world problems. Consequently, it can be concluded that the responses of students with mild intellectual disabilities to the Google Maps activity, which is based on a real-world problem, align well with the

MEA components. Furthermore, teachers can facilitate the acquisition of new mathematical knowledge by leveraging both in-class and out-of-class experiences. This might involve associating complex mathematical concepts with simpler, familiar ones or connecting new content to real-life, extracurricular experiences of students with mild intellectual disabilities (Hord, 2023).

Suggestions based on the findings from students with mild intellectual disabilities are presented as follows. Firstly, given the limited number of mathematical modeling studies in mathematics education for students with mild intellectual disabilities, it is recommended to increase the number of MEA design studies tailored to this group. Additionally, since evaluation approaches specific to mathematical modeling activities for students with mild intellectual disabilities are scarce, existing evaluation frameworks in the literature could be further developed to assess MEAs effectively. Lastly, while this study focused on designing an MEA at the high school level, it is suggested that similar studies be conducted at the elementary and middle school levels. Such efforts could enhance the body of literature on mathematical modeling for students with mild intellectual disabilities and provide more comprehensive educational support across different grade levels.

The study was confined to three high school students with mild intellectual disabilities who were receiving inclusive practice at a school affiliated with the Ministry of National Education. Furthermore, the MEA developed and implemented in this study was limited to four components—introduction phase, warm-up questions, problem situation, and presentation of solutions—due to its focus on students with mild intellectual disabilities.

Genişletilmiş Özet

Giriş

Matematiksel modelleme, gerçek dünyadaki problemleri matematiksel yöntemlerle analiz ederek çözüm üretmeyi hedefleyen önemli bir yaklaşımdır (Borromeo-Ferri, 2006; Maaß, 2006). Bu süreç, öğrencilerin problem çözme, analitik düşünme ve yaratıcılık becerilerini geliştirmelerine olanak sağlar. Matematiksel modelleme, öğrencilerin soyut matematiksel kavramları somut durumlarla ilişkilendirmesini kolaylaştırır ve bu becerilerin yaşam boyu kullanımını teşvik eder (Bukova Güzel, 2019). Ulusal Matematik Öğretmenleri Konseyi (NCTM), problem çözmeyi matematik öğretiminin temel hedeflerinden biri olarak tanımlar (NCTM, 2000). Ancak, bu beceriyi geliştirmek, özellikle özel gereksinimli öğrenciler için daha fazla çaba ve uyarlanmış yöntemler gerektirir. Hafif düzeyde zihinsel yetersizliği olan öğrenciler, dikkat sürelerinin kısa olması ve soyut kavramları anlamakta güçlük çekmeleri nedeniyle matematiksel problem çözmede zorluklar yaşayabilirler (Başal ve Batu, 2002). Bu bağlamda, matematiksel modelleme etkinlikleri (MOE), öğrencilerin gerçek dünya problemlerini çözmek için matematiksel modeller geliştirmelerine olanak sağlayarak özel gereksinimli öğrenciler için etkili bir öğrenme ortamı sunar (Chamberlin ve Moon, 2008). Modelleme etkinlikleri, yalnızca matematiksel becerileri geliştirmekle kalmaz, aynı zamanda öğrencilerin yaratıcı düşünme kapasitelerini de destekler (Lesh ve Zawojewski, 2007). Bu çalışmanın amacı, hafif düzeyde zihinsel yetersizliği olan öğrenciler için ADDIE öğretim tasarımı modeli çerçevesinde hazırlanmış bir modelleme etkinliğinin tasarımını ve uygulanmasını ele almaktır. Google Haritalar kullanılarak hazırlanan bu etkinlik, öğrencilerin uzunluk ve ölçme öğrenme alanında problem çözme becerilerini geliştirmeyi hedeflemektedir.

Yöntem

Araştırma Modeli olarak Tasarım ve Geliştirme Araştırması (TGA) yönteminin 1. tip geliştirme araştırması kullanılmıştır. Araştırmanın katılımcılarını oluşturan öğrencilerin seçiminde amaçlı örnekleme yöntemlerinden ölçüt örnekleme kullanılmıştır. Bu çalışmada ölçüt öğrencilerin hafif düzeyde zihinsel yetersizliği olan öğrenci olmalarıdır. Araştırmanın katılımcılarını Ege bölgesinin bir ilçesinde yer alan orta sosyoekonomik düzeye sahip ailelerin çocuklarının öğrenim gördüğü bir lisede eğitimine devam eden hafif düzeyde zihinsel yetersizliği olan üç öğrenci oluşturmaktadır. Bu çalışmada, ADDIE öğretim tasarımı modeli Analiz (Analysis), Tasarım (Design), Geliştirme (Development), Uygulama (Implementation), Değerlendirme (Evaluation) çerçevesinde Google Haritalar etkinliği hazırlanmış ve uygulanmıştır. ADDIE modeli, öğretim tasarımı sürecinde sistematik bir yaklaşım sunarak etkinliklerin daha etkili ve amaca uygun bir şekilde geliştirilmesini sağlamaktadır. Modelin aşamaları Analiz, Tasarım ve Geliştirme, Uygulama ve Değerlendirme olmak üzere üç başlık altında toplanmıştır. İlk olarak Analiz aşaması, öğrencilerin mevcut öğrenme düzeylerini ve ihtiyaçlarını belirlemeyi hedeflemiştir. Bu aşamada, hafif düzeyde zihinsel yetersizliği olan öğrencilerin, özellikle matematiksel modelleme ve problem çözme süreçlerinde karşılaştıkları zorluklar ele alınmıştır.

Analiz sürecinde Rehberlik ve Araştırma Merkezi (RAM) ile görüşmeler yapılmış, öğrencilerin akademik durumları, matematiksel becerileri ve öğrenim ihtiyaçları detaylı bir şekilde değerlendirilmiştir. Ayrıca, öğrencilerin ön bilgi düzeylerini belirlemek amacıyla bireyselleştirilmiş eğitim programları (BEP) göz önünde bulundurulmuş, temel matematiksel beceriler (örneğin, eldeli toplama, çıkarma ve uzunluk ölçme) tespit edilmiştir. Gerçek dünya problemlerine yönelik ilgileri dikkate alınarak, Google Haritalar gibi tanıdık bir araç üzerinden problem çözme süreçlerine yönelik bir ihtiyaç olduğu belirlenmiştir. İkinci olarak Tasarım aşamasında, belirlenen ihtiyaçlar doğrultusunda etkinlikler planlanmış ve yapılandırılmıştır. Matematiksel modelleme etkinlikleri (Model Oluşturma Etkinlikleri - MOE) çerçevesinde dört temel bileşen (giriş, hazır oluş soruları, problem durumu ve çözümlerin sunumu) esas alınmıştır. Etkinliğin amacı, öğrencilerin matematiksel düşünme ve problem çözme becerilerini geliştirmek olmuştur. Bu doğrultuda, matematik dersi müfredatına uygun kazanımlar belirlenmiştir. Örneğin, öğrencilerin "en fazla üç basamaklı sayılarla işlem yaparak problemleri çözme" ve "uzunluk ölçme birimlerini dönüştürme" becerileri hedeflenmiştir. Tasarım sürecinde, öğrencilerin dikkatini çekmek ve öğrenme sürecini desteklemek amacıyla görsel materyaller, videolar ve rehber sorular kullanılmıştır. Ayrıca, dijital araçlardan (örneğin, etkileşimli tahta, WhatsApp, Zoom) yararlanılarak öğretim ortamı zenginleştirilmiştir. Geliştirme aşaması ise, tasarlanan materyallerin uygulanabilir hale getirilmesini içermiştir. Bu aşamada, öğrencilerin etkinliklere hazırlanmasını kolaylaştırmak amacıyla bir tanıtıcı video hazırlanmış ve öğrencilerle paylaşılmıştır. Etkinlik kağıtları, MOE bileşenlerine uygun olacak şekilde detaylı olarak hazırlanmıştır. Geliştirilen materyaller, özel eğitim öğretmenleri ve matematik eğitimcileri tarafından incelenmiş, bu uzmanların görüşleri doğrultusunda gerekli düzenlemeler yapılmıştır. Ayrıca, etkinlik ortaokul düzeyinde bir öğrenciyle uygulanmış, elde edilen geri bildirimler doğrultusunda iyileştirmeler gerçekleştirilmiştir. Üçüncü olarak Uygulama aşaması, Ege Bölgesi'ndeki bir lisede hafif düzeyde zihinsel yetersizliği olan üç öğrenciyle gerçekleştirilmiştir. Etkinlik, destek eğitim odasında uygulanmış ve öğrencilerin her bir aşamada öğretmen rehberliğinde yönlendirilmesi sağlanmıştır. Öğrencilere giriş bölümünde tanıtıcı video izletilmiş, ardından hazır oluş soruları ile öğrencilerin problem bağlamına yönelik düşünceleri değerlendirilmiştir. Problem durumu bölümünde öğrencilerin çözüm için kendi modellerini geliştirmeleri desteklenmiş, çözümlerin sunumu aşamasında ise öğrenciler oluşturdukları çözümleri sınıf arkadaşlarına açıklamıştır. Uygulama sürecinde ses kayıtları alınmış, gözlem notları tutulmuş ve etkinlik kağıtları toplanmıştır. Değerlendirme aşamasında ise, uygulamanın etkisi ve etkinliklerin MOE bileşenlerine uygunluğu analiz edilmiştir. Matematik eğitimcisi ve özel eğitim uzmanlarının katkılarıyla etkinlik, biçimsel ve içerik açısından değerlendirilmiştir. Ayrıca, öğrencilerin etkinlik sürecinde verdikleri cevaplar analiz edilerek MOE bileşenlerine uygunluğu gözlemlenmiştir. Uzmanlardan alınan geri bildirimler doğrultusunda etkinliğin güçlü yönleri belirlenmiş, iyileştirilmesi gereken noktalar tespit edilmiştir. Bu süreçte, etkinliğin MOE değerlendirme formu ile sistematik bir şekilde incelenmesi sağlanmıştır.

Bulgular

Araştırmada, geliştirilen etkinliğin MOE bileşenlerine (giriş, hazır oluş soruları, problem durumu ve çözümlerin sunumu) uygun olduğuna dair ait bulgular elde edilmiştir. İlk olarak giriş bölümünde öğrencilere sunulan tanıtıcı video ve Google Haritaları kullanma görevi, öğrencilerin etkinliğe ısınmalarını sağlamıştır. Öğrenciler, iki lokasyon arasındaki uzaklıkları hesaplama ve bu uzaklıkların anlamı üzerine fikir yürütme konusunda başarı göstermiştir. İkinci olarak hazır oluş soruları, öğrencilerin problem durumunun bağlamına ilişkin farkındalıklarını artırmıştır. Ancak, "Ev ile okul arası mesafeyi bir aracın kilometre sayacı ile bulabilir miyiz?" sorusuna öğrencilerin isteksiz yanıt verdiği gözlemlenmiştir. Üçüncü olarak problem durumunda, öğrenciler verilen bilgileri kullanarak iki farklı durum tanımlamış ve matematiksel hesaplamaları başarıyla yapmıştır. Problemin çözümünde eksik bir mesafe, verilen mesafelerin toplamından çıkarılarak hesaplanmış ve öğrenciler bu çözümü doğru bir şekilde tamamlamıştır. Son olarak çözümlerin sunumunda öğrenciler, çözümlerini revize ederek hatalarını fark etmiş ve çözümlerini başarıyla sunmuştur. Ayrıca, problem durumuna bağlı olarak oluşturulan yeni bir soruyu da başarılı bir şekilde yanıtlamışlardır.

Tartışma, Sonuç ve Öneriler

Bu çalışma, hafif düzeyde zihinsel yetersizliği olan öğrencilerin gerçek dünyadaki problemleri anlamalarına ve bu problemleri matematiksel modelleme aracılığıyla çözebilmelerine katkı sağladığını göstermiştir. Bulgular, MOE bileşenlerinin öğrencilerin çözüm süreçlerini anlamaları ve yönetmelerine yardımcı olduğunu ortaya koymuştur. Google Haritaların eğitimde

kullanımı, özellikle "Uzunluk ve Ölçme" öğrenme alanında, öğrencilerin çalışmalara olan ilgisini artırmıştır. Araştırma, MOE bileşenlerine uygun olarak tasarlanan etkinliğin, hafif düzeyde zihinsel yetersizliği olan öğrenciler için matematiksel modelleme becerilerinin geliştirilmesinde etkili olduğunu göstermiştir. Gelecekteki çalışmaların, bu tür etkinliklerin farklı yaş grupları ve öğrenme düzeyleri için tasarlanmasını önerilmektedir. Ayrıca, bu etkinliklerin değerlendirme yöntemlerinin geliştirilmesi, öğrencilerin bireysel ihtiyaçlarına daha iyi cevap verilmesini sağlayabilir.

Author Contribution: First author 60.00% and second author 40.00%

Conflict of Interest: There is no conflict of interest among the authors.

Ethical Statement: In this study, we declare that we have complied with the rules outlined in the "Directive on Scientific Research and Publication Ethics of Higher Education Institutions" and have not engaged in any actions that violate these rules. We further affirm that all authors have contributed to the study, that there are no conflicts of interest among the authors, and that the authors assume full responsibility for any ethical violations.

Ethical Permission: Ethical permission was obtained from the Institute of Science Ethics Committee of Balıkesir University (Date: 28.02.2023, 2023/1).

Finance: This research did not receive any financial support.

Data Availability Statement: The data collected during this study are available from the authors upon request.

Use of Artificial Intelligence for Writing Assistance: Authors declare that no artificial intelligence is used for writing assistance.

References

Bağlama, B. (2018). *Zihin yetersizliği olan öğrencilere matematik problem çözme becerisinin öğretiminde doğrudan öğretim yöntemiyle sunulan bilgisayar destekli video ile model olma öğretiminin etkililiği [Effectiveness of computer supported video modeling presented with direct instruction method on teaching mathematical problem solving skills to students with intellectual disability]* [Unpublished doctoral thesis]. Yakın Doğu University.

Başal, M., & Batu, E. S. (2002). Zihin özürlü öğrencilere okuma yazma öğretme konusunda alt özel sınıf öğretmenlerinin görüş ve önerileri [Opinions and suggestions of lower special class teachers about teaching reading and writing to mentally handicapped students]. *Ankara University Faculty of Educational Sciences Journal of Special Education, 3*(2) 85-98. https://doi.org/10.1501/Ozlegt_0000000067

Borromeo Ferri, R. (2006). Theoretical and empirical differentiations of phases in the modelling process, *Zentralblatt für Didaktik der Mathematik*, *3*8(2), 86-95. https://link.springer.com/article/10.1007/BF02655883

Bouck, E. C., & Flanagan, S. (2009). Assistive technology and mathematics: What is there and where can we go in special education. *Journal of Special Education Technology, 24*(2), 17-30. https://doi.org/10.1177/016264340902400202

Bukova Güzel, E. (2019). *Matematik Eğitiminde Matematiksel Modelleme* [*Mathematical Modeling in Mathematics Education]*. Pegem Academy.

Bryant, D. P., Bryant, B. R., & Smith, D. D. (2008). *Teaching students with special needs in inclusive classrooms*. Sage Publications.

Büyüköztürk, Ş., Çakmak, E. K., Akgün, Ö. E., Karadeniz, Ş. & Demirel, F. (2018). *Bilimsel Araştırma Yöntemleri* [*Scientific Research Methods*]. Pegem Academy.

Chamberlin, S. A., & Chamberlin, M. T. (2001). On-time Arrival. Unpublished text

Chamberlin, S. A., & Moon, S. M. (2005). Model-eliciting activities as a tool to develop and identify creatively gifted mathematicians. *Journal of Secondary Gifted Education*, *17*(1), 37-47. https://doi.org/10.4219/jsge-2005-3

Chamberlin, S. A., & Moon, S. M. (2008). How does the problem based learning approach compare to the model-eliciting activity approach in mathematics. *International Journal for Mathematics Teaching and Learning*, *9*(3), 78-105. https://www.cimt.org.uk/journal/chamberlin.pdf

English, L. D., & Watters, J. J. (2004). Mathematical modelling with young children. In M. Hoines, & B. Fugelsted (Eds.), *Proceedings of the 28th annual conference of the International Group for the Psychology of Mathematics Education*, (2), 335-342.. Bergen: PME. https://api.semanticscholar.org/CorpusID:55967278

English, L. D., & Watters, J. J. (2005). Mathematical modelling in the early school years. *Mathematics Education Research Journal*, *16*(3), 58–79. https://link.springer.com/article/10.1007/BF03217401

English, L. (2006). Mathematical modeling in the primary school: Children's construction of a consumer guide. *Educational Studies in Mathematics*, *63*, 303–323. https://link.springer.com/article/10.1007/s10649-005-9013-1

Eric, C. C. M. (2008). Using model-eliciting activities for primary mathematics classrooms. *The Mathematics Educator*, *11*(1/2), 47-66. https://math.nie.edu.sg/ame/matheduc/tme/tmeV11/07%20Article%20by%20Eric%20Chan.pdf

Eripek, S. (2003). Rastlanma Sıklığı Yüksek Olan Çocuklar [Children with High Prevalence]. In A. Ataman (Ed.), *Özel Eğitime Giriş [Introduction to Special Education]* (pp. 60-78). Gündüz Education and Publishing.

Goldman, S. R., & Hasselbring, T. S. (1997). Achieving meaningful mathematics literacy for students with learning disabilities. *Journal of Learning Disabilities*, *30*(2), 198-208. https://doi.org/10.1177/002221949703000207

Gönener, H. D., Güler, Y., Altay, B., & Açıl, A. (2010). Caring of a mental-lmpaired child at home and nursing approach. *Gaziantep Medical Journal*, *16*(2), 57-65.

Gürbüz, R., & Doğan, M. F. (2019). Giriş: Matematiksel modellemeye disiplinler arası bakış: Bir STEM yaklaşımı [Introduction: An interdisciplinary approach to mathematical modeling: A STEM approach.] In R. Gürbüz & M. F. Doğan (Eds) (2nd edition). *Matematiksel modellemeye disiplinler arası bakış: Bir STEM yaklaşımı [An interdisciplinary approach to mathematical modeling: A STEM approach],* (pp.1-5). Pegem Academy.

Güven, M. (2008). Öğretim Materyali ve Tasarım Süreci [Instructional Material and Design Process] In K. Selvi (Ed.), *Öğretim Teknolojileri ve Materyal Tasarımı [Instructional Technologies and Material Design]* (pp. 165-212). Anı Publishing.

Hart, J. E., & Whalon, K. J. (2012). Using video self-modeling via iPads to increase academic responding of an adolescent with autism spectrum disorder and intellectual disability. *Education and Training in Autism and Developmental Disabilities*, *47*(4), 438-446. https://www.jstor.org/stable/23879637?seq=1

Hohalan, G. G., McFarlard, J., & Picillo, B. A. (1994). Elementary school science for students with disabilities. *Remedial and Special Education*, *15*(2), 86-93.

Hord, C. (2023). Middle and high school math teaching for students with mild intellectual disability. *Support for Learning, 38*(1), 4-16. http://doi.org/10.1111/1467-9604.12425

Karabulut, A., & Yıkmış, A. (2016). The effectiveness of simultaneous prompting on teaching the skill of telling the time to individuals with mental retardation. *Bolu Abant Izzet Baysal University Journal of Faculty of Educationi*, *10*(2), 103-113. https://dergipark.org.tr/en/download/article-file/16708

Karasar, N. (2009*). Bilimsel araştırma yöntemi: Kavramlar-ilkeler-teknikler. [Scientific research method: Concepts-principles-techniques].* Nobel Publishing.

Kırcaali-İftar, G. (1998). *Özel Gereksinimli Bireyler ve Özel Eğitim* [*Individuals with Special Needs and Special Education]*. Anadolu University Open Education Faculty Publications.

Krouse, H. J. (2001). Video modelling to educate patients. *Journal of Advanced Nursing*, *33*(6), 748-757. https://doi.org/10.1046/j.1365-2648.2001.01716.x

Kroesbergen, E. H., & Van Luit, J. E. H. (2003). Mathematics interventions for children with special educational needs: A meta-analysis. *Remedial and Special Education, 24*(2), 97-114. https://doi.org/10.1177/07419325030240020501

Kuş, S., & Gökbulut, Y. (2021). Teacher opinions on mainstream and mathematics teaching. *Türkiye Bilimsel Araştırmalar Dergisi [Turkish Journal of Scientific Research]*, *6*(2), 345-358. https://dergipark.org.tr/tr/pub/tubad/issue/67618/939119

Lesh R., Hoover M., Hole B., Kelly A. & Post T. (2000). Principles for Developing Thought-Revealing Activities for Students and Teachers. In A. E. Kelly & R. A. Lesh (Eds.), Handbook of Research Design in Mathematics and Science Education (pp. 591-645). Lawrence Erlbaum Associates.

Lesh, R. A., & Doerr, H. M. (Eds.). (2003). *Beyond constructivism: Models and modeling perspectives on mathematics problem solving, learning, and teaching.* Routledge

Lesh, R., & Zawojewski, J. S. (2007). Problem solving and modeling. In F. Lester (Ed.), *The Handbook of research on mathematics teaching and learning* (2nd ed.) (pp.763–804). Reston, VA: National Council of Teachers of Mathematics; Charlotte, NC: Information Age Publishing

Lesh R., Young R., & Fennewald T. (2010). Modeling in K-16 Mathematics Classrooms – and Beyond. In R. Lesh, C. R. Haines, P. L. Galbraith & A. Hurford (Eds.), Modeling Students Mathematical Modeling Competencies (pp. 275-283). Springer.

Maaß, K. (2006). "What are modelling competencies?", *The International Journal on Mathematics Education*, *38* (2), 113-142.

Mete, P., Çapraz, C., & Yıldırım, A. (2017). Science education for intellectual disabled students. Atatürk University *Journal of Graduate School of Social Sciences*, *21*(1), 289-304. https://doi.org/10.18069/ataunisosbil.35347

Ministry of National Education [MoNE]. (2010). *Okullarımızda Neden Niçin Nasıl Kaynaştırma Yönetici, Öğretmen ve Aile Kılavuzu [Why Why How Inclusion in Our Schools Administrator, Teacher and Family Guide]*. Ministry of National Education General Directorate of Special Education, Guidance and Counseling Services.

Ministry of National Education [MoNE]. (2018). Özel Eğitim Hizmetleri Yönetmeliği [Regulation on Special Education Services]. Official Gazette, Date of Publication: July 7, 2018, No: 30471. https://orgm.meb.gov.tr/meb_iys_dosyalar/2018_07/09101900_ozel_egitim_hizmetleri_yonetmeligi_07072018.pdf

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

Montague, M., & Applegate, B. (1993). Mathematical problem solving characteristics of middle school students with learning disabilities. *Journal of Special Education*, 27(2), 175-201. https://doi.org/10.1177/002246699302700203

NCTM (National Council of Teachers of Mathematics). (2000). *Principles and Standards for School Mathematics. Reston,* VA: NCTM.

Ostad, A., & Sorensen, P. M. (2007). Private speech and strategy-use patterns: Bidirectional comparisons of children with and without mathematical difficulties in a developmental perspective. *Journal of Learning Disabilities*, *40*(1), 2-14. https://doi.org/10.1177/00222194070400010101

Öner, G. (2018). *Zihinsel engelli öğrencilere fen bilimleri dersinde canlıların sınıflandırılmasının bilgisayar destekli bireyselleştirilmiş öğretim yöntemiyle öğretiminin etkisi [The effect of teaching the classification of living things to students with intellectual disabilities in science course with computer-assisted individualized instruction method]* [Unpublished master thesis]. Necmettin Erbakan University.

Özkubat, U., & Özmen, E. R. (2018). Analysis of mathematical problem solving process of students with learning disability: Implementation of think aloud protocol. *Ankara University Faculty of Educational Sciences Journal of Special Education, 19*(1), 155-180. https://doi.org/10.21565/ozelegitimdergisi.299494

Özkubat, U. (2019*). Öğrenme güçlüğü olan öğrenciler ile düşük ve ortalama başarılı olan öğrencilerin matematik problemi çözerken kullandıkları bilişsel stratejiler ile üstbilişsel işlevler arasındaki ilişkilerin incelenmesi. [Investigating the relationships between cognitive strategies and metacognitive functions used by students with learning disabilities and low and average achieving students while solving mathematics problems]* [Unpublished doctoral thesis]. Gazi University.

Özsoy, Y., Özyürek, M., & Eripek, S. (2001). Özel *Eğitime Giriş* [Introduction to Special Education]. Karatepe Publishing.

Parmar, R. S., & Cawley, J. F. (1993). Analysis of science textbook recommendations provided for students with disabilities. *Exceptional Children*, *59*(6), 518-531.

Polo-Blanco, I., González López, M. J., Bruno, A., & González-Sánchez, J. (2024). Teaching students with mild intellectual disability to solve word problems using schema-based instruction. *Learning Disability Quarterly*, *47*(1), 3-15. https://doi.org/10.1177/07319487211061421

Richey, R. C. (1994). Developmental research: The definition and scope. *Educational Technology Research and Development, 42*(1), 7–22.

Richey, R. C., & Klein, J. D. (2005). Developmental research methods: Creating knowledge from instructional design and development practice. *Journal of Computing in Higher Education*, *16*(2), 23–38.

Richey, R., & Klein, J. (2008). Research on design and development. *Handbook of research for educational communications and technology,* 748-757.

Richey, R. C., & Klein, J. D. (2014). *Design and Development Research: Methods, Strategies, And Issues*. Routledge.

Rosenzweig, C., Krawec, J., & Montague, M. (2011). Metacognitive strategy use of eighth-grade students with and without learning disabilities during mathematical problem solving: A think-aloud analysis. *Journal of Learning Disabilities*, *44*(6) 508-520. https://doi.org/10.1177/0022219410378445

Scruggs, T. E., & Mastropieri, M. A. (1993). Current approaches to science education: implications for mainstream instruction of student with disabilities. *Remedial and Special Education*, *14*(1), 15-24.

Sezgin, N. (2016). *Süreç temelli öğretiminin hafif düzeyde zihinsel yetersizliği olan öğrencinin yazma becerisine etkisinin incelenmesi [Examining the effect of process-based instruction on the writing skills of students with mild intellectual disability]* [Unpublished master thesis]. Karadeniz Teknik University.

Shin, M., & Bryant, D. P. (2015). A synthesis of mathematical and cognitive performances of students with mathematics learning disabilities. *Journal of Learning Disabilities*, *48*(1), 96-112. https://doi.org/10.1177/0022219413508324

Sucuoğlu, B., & Kargın, T. (2010). *İlköğretimde kaynaştırma uygulamaları [Inclusion practices in primary education]*. Kök Publishing.

Swanson, H. L., & Jerman, O. (2006). Math disabilities: A selective meta-analysis of the literature. *Review of Educational Research*, *76*(2), 249-274. https://doi.org/10.3102/00346543076002249

Şimşek, A. (2013). Öğretim tasarımı ve modelleri [Instructional design and models]. In K. Çağıltay & Y. Göktaş (Eds.), *Öğretim teknolojilerinin temelleri: Teoriler, araştırmalar, eğilimler* [Foundations of instructional technologies: Theories, research, trends] (pp. 99–116). Pegem Academy.

Tekin Dede, A., & Bukova Güzel, E. (2014). Model eliciting activities: The theoretical structure and its example. *Ondokuz Mayis University Journal of Education Faculty, 33*(1), 95-111. https://dergipark.org.tr/tr/download/article-file/188037

Yıldırım, A., & Şimşek, H. (2006). *Sosyal Bilimlerde Nitel Araştırma [Qualitative Research in Social Sciences]*. Seçkin Publishing.

Yılmaz, E. B. (2020). *Matematik öğretmen adaylarının çevrimiçi eğitimde harita kullanımına yönelik ders planı hazırlama ve uygulama deneyimleri. [Pre-service mathematics teachers' experiences in preparing and implementing lesson plans for the use of maps in online education]* [Unpublished master thesis]. Osmangazi University.

Yiğit E. C. (2012). *Öğretim Sistemi Tasarımı (ISD) / ADDIE Modeli* [Instructional System Design (ISD) / ADDIE Model]. https://ikegitimvegelisim.wordpress.com/2012/02/28/ogretim-sistemi-tasarimi-isdaddie-modeli/

Yu, S. Y., & Chang, C. K. (2009). What did Taiwan mathematics teachers think of model-eliciting activities and modeling? In G. Kaiser, W. Blum, R. B. Ferri & G. Stillman (Eds.), *Trends in teaching and learning of mathematical modelling international perspectives on the teaching and learning of mathematical modelling,* (pp. 147-156). Springer.