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Exploring Mathematics Teacher Candidates' Instrumentation Process of Generative Artificial Intelligence for Developing Lesson Plans

Matematik Öğretmen Adaylarının
Üretken Yapay Zeka ile Ders Planları Geliştirme Süreçlerindeki Kullanım Şemaları

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Özet

İnsanlar ve teknolojiler arasındaki etkileşim yıllardır devam etmektedir. ChatGPT gibi üretken yapay zeka araçları, son zamanlarda eğitim başta olmak üzere çeşitli alanlarda çeşitli amaçlarla kullanılmaktadır. Yapay zeka araçları, yükseköğretim kurumlarının misyon ve vizyonunda köklü değişikliklere sebep olma potansiyeline sahip olup, öğretmen yetiştiren yükseköğretim kurumlarını da etkilemektedir. Araçlar, "kullanım şemalarının" oluşumu veya gelişimi yoluyla insan faaliyetlerini etkiler ve yönlendirirler. Bu çalışmanın amacı, matematik öğretmen adaylarının ChatGPT ile ders planları geliştirme süreçlerini, kullanım amaçları ve kullanım şemaları özelinde incelemektir. Araştırma, 2022-2023 akademik yılının bahar döneminde gerçekleştirilmiş ve bir durum çalışması olarak tasarlanmıştır. Katılımcılar Türkiye'de bir eğitim fakültesinin 2. sınıfında öğrenim gören on matematik öğretmen adayından oluşmuştur. Çalışma sekiz hafta sürmüştür. Çalışmada kullanılan veri toplama aracı olarak, katılımcıların yapay zeka ile etkileşime girdiklerinde haftada en az bir kez doldurdukları günlükler, katılımcıların ChatGPT ile yaptığı konuşmaların ekran görüntüleri ve katılımcıların hazırladıkları ders planları kullanılmıştır. Toplanan veriler, enstrümantal yaklaşım çerçevesinde içerik analizine uygun olarak çözümlenmiştir. Analiz sonuçları, ders planlama süreci boyunca matematik öğretmen adaylarının altı farklı kullanım amacı ile ilişkili altı kullanım türünde ChatGPT'yi kullandıklarını ortaya koymuştur.

Anahtar Sözcükler: ChatGPT; Enstrümantal Yaklaşım; Ders Planlama; Öğretmen Eğitimi; Kullanım Şemaları; Üretken Yapay Zeka

Abstract

The interaction between humans and technologies has a long historical lineage. Presently, generative artificial intelligence tools such as ChatGPT are being employed for various purposes, especially in education and across diverse domains. These artificial intelligence tools carry significant potential to induce profound transformations in the overarching mission and vision of higher education institutions, thereby exerting a considerable influence on higher education institutions dedicated to training teaching professionals. In fact, tools influence and guide human activities through the genesis or development of "utilization schemes". This study aims to explore mathematics teacher candidates' instrumentation process of ChatGPT for developing lesson plans with particular attention to the utilization purposes and utilization schemes. The research was designed as a case study conducted during the spring semester of the 2022-2023 academic year. The participants included ten mathematics teacher candidates. The study lasted for eight weeks. The data collection tools used in the study included journals filled out by the participants at least once a week when they interacted with artificial intelligence, screenshots of the conversations between the participants and ChatGPT, and the lesson plans prepared by the participants. The collected data was analyzed within the framework of the instrumental approach. The content analysis results revealed that during the lesson planning process, teacher candidates used ChatGPT in six different utilization types associated with six distinct utilization purposes.

Keywords: ChatGPT; Generative AI Tools; Instrumental Approach; Lesson Planning; Teacher Training; Utilization Schemes

Human-technology interaction is a field of research and development that lies at the intersection of computer science, cognitive psychology, and ergonomics. Its primary objective is to design interactive systems that facilitate communication and collaboration between users and technologies. Technological advancements not only bring about changes in human life but also shape technological developments according to human needs. Technology has revolutionized the field of

education as well. Artificial intelligence technologies have gained significant importance in education in recent years. The teacher training policies of higher education institutions have been prioritized on the agendas of developed countries (OECD, 2023). Higher education institutions are among the foremost intellectual environments where progress and advancements occur worldwide (Altbach, 2002). As such, these institutions act as receptors of global developments and share similar sensibilities with the world.

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Therefore, the inclusion of teacher education on the agenda of developed countries necessitates the internationalization of activities in this field, with the goal of elevating them to an international level (Hamutoglu et al., 2020). Generative modeling is an artificial intelligence (AI) technique that generates synthetic artifacts by analyzing training examples; learning their patterns and distribution; and then creating realistic facsimiles (Jovanovic & Campbell, 2022). In order to provide a wide variety of content, Generative AI uses generative modelling and advances in deep learning.

In the contemporary era, artificial intelligence processes texts with extraordinary success, often generating results indistinguishable from what humans can produce. Large language models are generative artificial intelligence models that produce human-like language (OpenAI, 2022). ChatGPT is an artificial intelligence model that can process and generate natural language text, providing human-like responses to a wide range of questions and prompts (Doshi et al., 2023). ChatGPT was released by the American company OpenAI in November 2022. Its public release has brought about revolutionary innovations and sparked numerous discussions in various fields.

The usage of generative artificial intelligence based on Natural Language Processing and deep learning has enabled ChatGPT to generate human-like texts and maintain a conversational style with more realistic natural dialogues (Tlili et al., 2023). ChatGPT has gained significant momentum in recent times due to its ability to perform complex tasks successfully. In fact, Rudolph et al. (2023) have stated that ChatGPT is the most advanced chatbot, as it can generate impressive writings within seconds, setting it apart from other generative AI models.

The number and quality of academic studies conducted on ChatGPT's integration into the field of education and in particular into the field of higher education, are currently limited, as for other domains. While some researchers have focused on investigating the potential benefits, limitations, and risks associated with the use of ChatGPT in education (Rudolph et al., 2023), others have taken a forward-looking perspective and conducted research on the potential impacts and transformations that ChatGPT could have on teaching and learning (Baidoo-Anu & Owusu Ansah, 2023). Mhlanga (2023) has reported that ChatGPT has the potential to completely transform students' methods of acquiring knowledge in the field of education, emphasizing the critical importance of modifying teaching methods and techniques to prevent the weakening of critical thinking skills, as students may unquestioningly rely on responses generated by artificial intelligence instead of expressing their own ideas.

Studies on the misuse of ChatGPT by students have also gained attention and interest, especially at the higher education level. In a study by Susnjak (2022), it was highlighted that ChatGPT posed a potential threat to the integrity of online exams, with its ability to demonstrate critical thinking skills and generate highly realistic texts with minimal input. The author suggested using alternative exam formats such as oral exams and AI plagiarism detection software. Similarly, Shen-Berro (2023) reported a similar concern regarding the use of ChatGPT in schools, where students tend to rely solely on texts generated by artificial intelligence for their assignments and projects, emphasizing the need for caution.

Moreover, the majority of studies conducted in the field of education in the literature examine the texts generated by artificial intelligence technologies to respond to prompts and analyze the language in these texts (Suchikova, 2023). For example, Chang and Kidman (2023) analyzed the comprehensibility of ChatGPT's responses in conversations about geography education and determined that the responses provided by artificial intelligence were appropriate.

Another study that examined the texts generated by ChatGPT focused on the differences between feedback texts given to students through evaluation by ChatGPT and evaluation by instructors in a data science course (Dai et al., 2023). Additionally, Cooper (2023) examined ChatGPT's responses to science education-related questions and suggested that ChatGPT could be used in designing science lesson materials, preparing exam questions, and creating evaluation rubrics.

The literature review also indicates that research on generative AI tools like ChatGPT primarily focuses on the analysis of responses and texts generated. However, no studies have been found that examine the lesson plans prepared by teachers or teacher candidates with the assistance of ChatGPT. Investigating the use of generative AI tools by teachers and teacher candidates can provide valuable insights into the role of generative AI in education and its impact on the teaching profession and on higher education institutions that train teachers. This study is essential in two aspects: firstly, it reveals the utilization types and purposes of ChatGPT by teacher candidates through an instrumental lens; secondly, it addresses the initial experiences of teacher candidates in using artificial intelligence for lesson planning in their professional activities.

The changes and contributions that Generative AI tools like ChatGPT will bring to the teaching profession appear promising (Biswas,2023). In fact, the usage of Generative AI tools seems to have already been adopted by a significant portion of people from various professions, including teachers, for various purposes. Considering that the integration of these tools into the education system does not occur spontaneously (Laborde, 2002), this usage must be framed, guided, and trained for effective use as well as ethical, malpractice, and honesty concerns.

In-service and pre-service training on the use of a tool for educational purposes should be constructed, taking into account the utilization schemes constructed through an instrumental genesis. In other words, in order to achieve an internalized and accepted integration of Generative AI tools by teachers and teacher candidates, it is essential to determine in advance the ways in which they use ChatGPT in their professional activities. In this regard, this research is important in shedding light on the instrumental genesis constructed by teacher candidates when using ChatGPT.

The investigation of how the use of generative AI tools by teachers and teacher candidates influences their professional activities is an important research topic that can provide valuable insights into the role of generative AI in education and its impact on the teaching profession. The increasing importance of lifelong learning, the need for innovative approaches in digital learning platforms, the individualization of learning environments, the growing use of the internet, and the significance of innovative technologies such as augmented reality and artificial intelligence all necessitate that the learners acquire the skills to meet the demands of the present and future. To meet the needs of learners, higher education institutions, as one of the most crucial components of the education system, are expected to rapidly adapt to technology (Yorganci, 2022). In this context, the aim of this study is to explore mathematics teacher candidates' instrumental genesis of ChatGPT for developing lesson plans with particular attention to the utilization purposes and utilization schemes.

Theoretical Framework

At the core of human-technology interaction, there are mental and perceptual processes involved in human-machine interaction. In the perspective that tools shape and direct human activities, but also human activities orient and shape tools, the instrumental theory was developed (Rabardel, 1995). The instrumental approach is a theoretical framework that emerged in the mid-1990s in France when it was realized that traditional constructivist frameworks were inadequate for analyzing computer algebra systems (Artigue & Trouche, 2021). Artigue (2007) denotes that this approach is less learner-centered, but it provides a broader systematic perspective that focuses more on the instrumental dimension of learning and teaching. The instrumental theory is a theoretical approach that examines the relationship between tools and the learning process, as well as the techniques learners develop in tool use and their conceptual developments (Trouche, 2004). The instrumental approach has been employed in research that involves the observation of the outcomes of learners' learning in technology-rich environments.

Indeed, Vygotsky (1978) states that artificial systems expand the cognitive capacity of the person by improving his ability to perform his actions in an environment. Rabardel (1995)

distinguishes between tool and instrument and defines the tool as "an entity built by designers in anticipation of some uses" and the instrument as "a dual entity composed at the same time by the tool and by the associated utilization schemes of the user". The construction processes of the utilization schemes, named instrumental genesis, can also be defined as the acceptance of a tool to solve a problem and the transformation of the tool in line with the need. Hence, an instrument is an abstract notion consisting of both the tool and the mental schemes that the user develops to use while performing certain tasks (Drijvers & Trouche, 2008). In fact, the instrument is specific to each individual and hence unique for each individual.

The instrumental genesis is a dual process comprising instrumentation and instrumentalization (Rabardel, 1995). Instrumentation is the user's adaptation to the tool and relates to the genesis of the human side of the instrument by developing, adapting, or reorganizing conceptualizations and schemes. The attribution of functions to the tool and the technical transformation of the tool by the user is instrumentalization (Trouche, 2004). As a matter of fact, the relationship between a tool and an individual is complex; there intervene the habits, purposes, anticipations, expectations of the individual but also the interface, the production purposes, the capacities, the limitations of the tool. The schematic representation of the instrumental genesis process is given in ▮ Figure 1.

▮ Figure 1.
Schematic representation of the instrumental genesis process (Trouche, 2004)
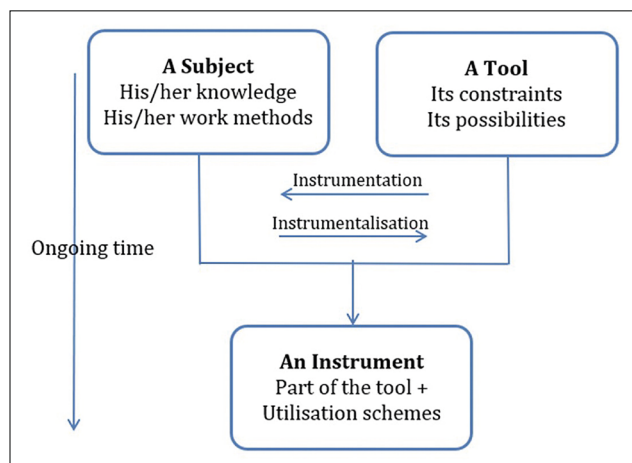
An individual has to develop utilization schemes and efficient procedures through an instrumental genesis in order to manipulate a tool (Drijvers & Trouche, 2008). A scheme is defined as the invariant organizations of activity in a given task (Vergnaud, 1996). In other words, they are more or less stable actions used to overcome certain tasks and situations. In addition, the scheme is also used to understand the structure of the relationship between the individual and the tool (Trouche, 2004).

These invariant organizations are structured by operational invariants developed in different contexts encountered for similar situations. The operational invariants are the implicit knowledge contained in the schemes; they are the theorems-in-action, that is, propositions believed to be true. According to Vergnaud (1996), schemes include an implicit or explicit representation of reality, which can be analyzed in terms of purposes, concepts in action (properties and relations), and theorems in action. However, there is always a great deal of implicitness in the schemes, which makes them difficult for the subjects to explain. Thus, the purposes of utilization are one of the determinant components for a mental scheme. In this research, we seek the utilization schemes through utilization types and utilization purposes of ChatGPT for a given task of developing lesson plans in order to explore the instrumental genesis of mathematics teacher candidates.

Professional Activity of Teachers

Teachers engage in various types of knowledge in their professional work. They need to go beyond understanding the scientific knowledge of a subject and acquire knowledge about how to teach that subject under different conditions. Pedagogical content knowledge refers to "the ways of representing and formulating the subject that make it comprehensible to others" (Shulman, 1986). On the other hand, technological tools that have entered all areas of life, including the field of education, in the past century have introduced the need for teachers to possess knowledge about how to effectively use technology in educational activities. Teachers need to have a conceptualization that considers the interactions among technology, content, and pedagogy in order to make meaningful use of technology during teaching activities (Angeli & Valanides, 2009). In addition to the activities teachers carry out in the classroom during their instructional activities, the pre-class preparation process of teaching is also crucial. One of the most important and visible aspects of teachers' lesson preparation process is the lesson plans they develop (Backfisch et al., 2020). In this context, it wouldn't be inaccurate to say that when teachers' lesson planning activities are compared to their in-class activities, lesson planning constitutes the invisible part of the iceberg.

Research Questions

How are the mathematics teacher candidates' instrumental genesis of ChatGPT for developing lesson plans?

The related sub-questions are:
1. What are the utilization types and utilization purposes of ChatGPT by teacher candidates during the lesson planning process?
2. How does the collaboration with ChatGPT reflect in the lesson plans created by teacher candidates as the final product?

Materials and Methods

This section presents a short description of the research design, information about the participants, procedure, data collection tools and details of the data analysis.

Research Design

This research is qualitative research and is designed as a case study to investigate "a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenology and context are not clearly evident" (Yin, 2009). The study was designed as a holistic single case study, as defined by Yin (2009). In this design, pre-service mathematics teachers who had the first experience of preparing lesson plans with ChatGPT were considered as the unit of analysis. Case studies are important for uncovering previously unknown aspects of a specific topic and providing a basis or guidance for future research (Patton, 2015). Hence, it was decided that designing this study as a case study was appropriate.

Participants

The research was conducted during the spring semester of the 2022-2023 academic year. The participants included ten mathematics teacher candidates enrolled in the second year of a state university in western Türkiye. All of the participants were female, and they were all voluntary to participate in the study. Prior to the research, structured interviews were conducted with teacher candidates; the aim of the study was explained, and they were asked to explain their knowledge about ChatGPT. Through these structured interviews, it was determined that the participants had no prior knowledge about ChatGPT, and they were included in the research on a voluntary basis. Thus, prior to the research, none of the participants had any knowledge of ChatGPT or had used it for educational purposes. The reason for selecting teacher candidates who had not previously used ChatGPT was to identify the elements related to the genesis of their usage of ChatGPT for a professional activity, in line with the purpose of the research. Additionally, the participants had received theoretical courses related to content knowledge and pedagogical content knowledge, but they had not received any practical training in schools. Hence, the participants had theoretical courses related to the analysis and construction of lesson plans but had not experienced the lesson plans in real classroom environments.

The participants of the research were coded as T1, T2, T3…, both during the analysis process and the reporting process. Some characteristics of the participants and the teaching and learning subjects they preferred for lesson planning are presented in ▮▮ Table 1.

Table 1.
Some Characteristics of the Participants and the Subjects they Preferred.

Teacher candidate	Year at the university	Gender	Subject preferred	Subject's grade level
T1	2nd year	Female	Algebra - Identities	8th grade
T2	2nd year	Female	Numbers and Operations - Fractions	5th grade
T3	2nd year	Female	Algebra - Prime factorization	8th grade
T4	2nd year	Female	Numbers and Operations - Divisibility rules	6th grade
T5	2nd year	Female	Algebra - Prime factorization	8th grade
T6	2nd year	Female	Geometry - Translation	8th grade
T7	2nd year	Female	Algebra - Prime factorization	8th grade
T8	2nd year	Female	Numbers and Operations - Sets	6th grade
T9	2nd year	Female	Numbers and Operations - Exponential expressions	6th grade
T10	2nd year	Female	Geometry - Angles	5th grade

Procedure and Data Collection Tools

In the study, ChatGPT-3.5 version was used. After all participants accessed ChatGPT, they were provided with instructions to integrate ChatGPT into the process of developing a lesson plan for teaching a subject of their choice at the middle school level. The lesson planning process, which involved different stages, such as subject selection, preparation, and interaction, lasted eight weeks.

During the first week of the data collection process, teacher candidates arrived in the classroom with technological equipment (laptop, phone, etc.). In this initial week, the teacher candidates' problems related to materials and software were resolved, and instructions were provided. The subsequent weeks of the data collection process were carried out through weekly meetings conducted on the online platform Teams. This way, researchers and teacher candidates were able to share their screens and engage in interaction.

The researcher did not intervene in the process of lesson plan development or in the final lesson plans. During the weekly sessions, the researcher listened to the experiences of the teacher candidates and only intervened as an authority in matters related to technical issues. The reason the researcher did not intervene in the participants' interactions with ChatGPT and their lesson planning processes, apart from technical issues, is to avoid influencing their instrumental processes and the schemes they created in these processes. This is because any interventions by the researcher might result in transmitting the researcher's schemes and/or instrumented techniques to the participants. Such a situation would lead the research away from its intended purpose.

During the data collection process, the teacher candidates were asked to save screenshots of their conversations with ChatGPT as images in a Word document. Additionally, they were requested to prepare journals in which they documented their activities, actions, interactions, experiences, and thoughts about their interactions with artificial intelligence at least once a week. During the weekly meetings, the progress, issues, and experiences of the teacher candidates were framed and discussed. At the end of the eight weeks, the lesson plans prepared by the teacher candidates were collected. Hence, the data collection tools used in the study included participants' journals filled out at least once a week when interacting with AI, screenshots of participants' conversations with ChatGPT and participants' lesson plans. Regarding the collected data, it was emphasized that the study and the data collected during the process would not affect the academic success of the participant teacher candidates. The data collection process of the research and the data collection tools are summarized and presented in Table 2.

Table 2.
Procedure and Data Collection Tools.

Process	Actions	Data Collection Tools
Week 1	Access to ChatGPT and Initiation	No data collected
	Choice of teaching subject for lesson planning	
Week 2 – Week 7	Interactions with ChatGPT to prepare lesson plans	Screenshots of participants' conversations with ChatGPT
		Participants' journals
Week 8	Finalization	Participants' lesson plans

Data Analyses

The collected data in the study was analyzed using a content analysis technique within the framework of the instrumental approach (Trouche, 2004). The content analysis technique is commonly used to examine texts such as interview transcripts, journals, and documents (Patton, 2015). Additionally, content analysis is an analytical method that involves a detailed examination of the underlying concepts in the data obtained in a research study and the identification of relationships between these concepts (Yin, 2009). The collected data in the study was analyzed and coded. Subsequently, these codes were combined to determine categories within the framework of utilization types and purposes. The categories and the codes used to create the categories were presented with direct quotations of participant statements associated with these codes.

In qualitative research, content analysis encompasses both inductive and deductive processes (Çelik et al., 2020). In this research, data analyses were primarily conducted following an inductive process, and for finalizing the categories, deductive processes were employed. In fact, the process of category creation initiates inductively and progresses deductively. In category creation, initially, small units are examined one by one, and codes are generated. Then, the codes are reviewed, and provisional categories are established. Each piece of data is examined for its compatibility with these categories, and this process unfolds inductively. Following data saturation, a deductive process is carried out to ensure the alignment between the created categories and the codes (Çelik et al., 2020). In this research, the researcher performed categorization using inductive analysis processes and subsequently assessed the alignment of categories with codes in a deductive manner. Thus, the final form of the study's categories, based on the usage type and purpose, was determined by the researcher, revealing different types of usage.

Validity and Reliability

To ensure the validity and reliability of the study, certain measures were taken. One of the measures to enhance the validity and reliability in qualitative research is extending the interaction process between the researcher and the participants of the study (Yıldırım & Şimşek, 2013). To achieve this, the researcher conducted weekly sessions with the participants over an eight-week period. Furthermore, during these weekly sessions, efforts were made to create an environment where the participants could comfortably express themselves without academic performance anxiety. The research purpose and process were shared with the participants, assuring them that their real names would not be used, and that anonymity would be maintained.

In addition to these measures, data triangulation was used to enhance the validity and reliability of the study. Data triangulation involves collecting data using different tools and methods (Patton, 2015). Triangulation was achieved by using Screenshots of participants' conversations with ChatGPT, Participants' journals, and Participants' lesson plans.

Additionally, direct quotations were used in presenting the study's findings. Thus, the categories and concepts derived from the raw data were supported with direct quotations, contributing to the validity and reliability of the study.

The study was approved by the Ethics Committee of xxx University Social and Human Sciences Research and Publication (protocol code 2023-03/06 and date of approval 31.03.2023).

Findings

In this section, the findings obtained from the analysis of the research data are presented under two subheadings. These subheadings include the findings related to the utilization types and purposes of ChatGPT by teacher candidates and the findings related to the place of ChatGPT in the teacher candidates' lesson plans.

Findings on the Utilization Types and Purposes of ChatGPT in Teacher Candidates' Lesson Planning Processes

Upon analyzing the data, it was found that teacher candidates made use of ChatGPT in different types of utilization during the lesson planning process. ■■ Table 3 synthetize the different types of utilization, the related utilization purposes revealed in this research and prospective teacher codes analyzed as having operated the utilization purpose.

■■ **Table 3.**
Utilization Types and Utilization Purposes.

| Utilization type	Utilization purpose	Prospective teachers
Tutor-Type Utilization	Obtaining the scientific knowledge	T1, T2, T3, T4, T6, T8, T9, T10
	Obtaining the pedagogical knowledge	T1, T2, T3, T4, T5, T6, T7, T8, T9, T10
Guide-Type Utilization	Consulting for ideas	T1, T2, T3, T4, T5, T6, T7, T8, T9, T10
	Seeking for suggestions	T1, T2, T3, T4, T5, T6, T7, T8, T9, T10
Validator-Type Utilization	Seeking for conformity or validation	T1, T4, T5, T7, T9
Simulator-Type Utilization	Simulating fictive students' behaviors, actions or responses	T3, T4, T6, T10
Organizer-Type Utilization	Obtaining organizational outlines	T2, T5, T10
Adjuster-Type Utilization	Seeking for complementary information to satisfy his/her expectations	T2, T4, T5, T8

The six types of utilization that findings revealed include tutor-type utilization, guide-type utilization, validator-type utilization, simulator-type utilization, organizer-type utilization and adjuster-type utilization. Subsequent headings present the findings specific to each type of utilization.

Tutor-Type Utilization

One of the revealed types of utilization through data analysis is the utilization of ChatGPT by teacher candidates as a tutor. In other words, the teacher candidates have demonstrated a tendency to use ChatGPT as a direct information-transmitting tool. The tutor-type utilization emerged in the lesson planning process of all teacher candidates. They employed ChatGPT in the tutor-type for two distinct purposes: providing scientific knowledge and delivering pedagogical knowledge.

As can be observed from the screenshot of the interaction presented in ▆ Figure 2, belonging to T1, the teacher candidate directly posed a question to ChatGPT, asking "How can I teach algebra to students?". This interaction reveals the usage of ChatGPT as a provider of pedagogical knowledge, highlighting the tutor-type utilization.

▆ Figure 2.
Screenshot of T1's tutor-type utilization.
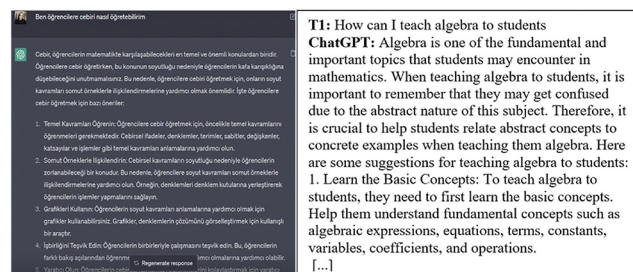
Similarly, participant T3 utilized ChatGPT as a pedagogical knowledge provider, through a tutor-type utilization, for preparing teaching materials. In her journal entry, she stated: "I asked about the colors I can use for a material. It seems that yellow and purple are commonly used for algebra subjects. I will organize my materials accordingly". Likewise, participant T8 employed a tutor-type utilization of ChatGPT for her lesson plan. In her journal, she wrote: "Since I couldn't exactly recall what a lesson plan is, I asked my artificial intelligence to provide me with an example lesson plan."

An example of using ChatGPT as a scientific knowledge provider through tutor-type utilization is presented in T4's screenshot provided in ▆ Figure 3. T4 also reflected this utilization in her journal entry, stating: "Today, I decided to discuss the subject of division with artificial intelligence. The subject that I will work on is numbers and operations. What is division? Do I have an idea about division? Do I know the division rules? […] I want to learn the answers to these questions."

▆ Figure 3.
Screenshot of T4's tutor-type utilization.
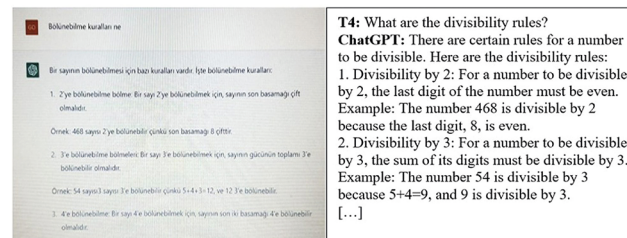
Guide-Type Utilization

It has been revealed that teacher candidates frequently use ChatGPT as a "Guide" during the process of lesson planning. In this type of utilization, teacher candidates consult ChatGPT for ideas and employ methods such as accepting and filtering appropriate suggestions to create a new, original, and personalized lesson plan according to their own schemes. The guide-type utilization has been identified in the lesson planning process of all participant teacher candidates. ▆ Figure 4 provides an example of T7's guide-type utilization of ChatGPT in organizing a competition within the classroom, specifically addressing potential challenges that may arise.

▆ Figure 4.
Screenshot of T7's guide-type.
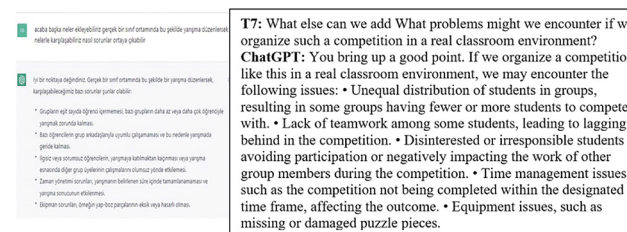
Regarding the guide-type utilization, T5, in her journal, stated, "In my opinion, the most challenging stage of lesson planning is the phase that involves motivating and captivating students. Like many people, students enjoy listening to stories and fairy tales. Therefore, I deemed it appropriate to start the lesson by telling a story. I asked ChatGPT to provide creative ideas during the process of constructing my story."

T4 also utilized ChatGPT as a Guide to group the class for gameplay. A screenshot excerpt showcasing T4's interaction related to this utilization is presented in ▆ Figure 5. T4 also mentioned the following statements in her journal regarding this interaction: "Now it's time to decide how to divide these groups with the help of artificial intelligence […] how will I determine these groups? I used AI to get some ideas about this. The suggestion it provided seemed reasonable".

Figure 5.
Screenshot of T4's guide-type utilization.
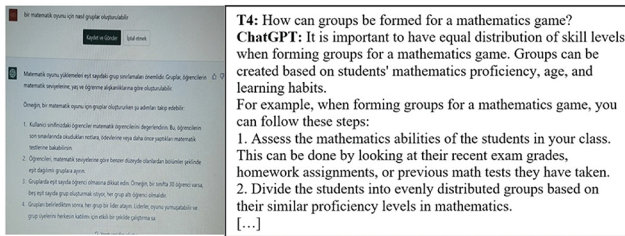
Validator-Type Utilization

Findings showed that some teacher candidates had used ChatGPT to seek approval for their ideas; this type of utilization is referred to as "validator-type utilization". In this type of utilization, teacher candidates expressed their own ideas for a specific task and sought validation from ChatGPT. The validator-type utilization of ChatGPT by T10 is given as an example in the screenshot illustrated in Figure 6.

Figure 6.
Screenshot of T10's validator-type utilization.

Similarly, T8, in her journal, used the following statements regarding the validator-type utilization of ChatGPT: "I wanted to ask if the material is suitable for the 7th-grade level, and it told me that the material is appropriate for the 7th-grade level and can provide effective learning through the use of proper teaching methods". Likewise, T9 also used ChatGPT as a validator and mentioned in her journal, "This week, I explained my own planned lesson to it. I was curious about its opinion, and it liked it very much".

Simulator-Type Utilization

As a result of the analysis, it has been revealed that some teacher candidates intend to use ChatGPT to simulate possible student responses and behaviors. This type of utilization has been categorized as simulator-type utilization. For instance, T3 requested ChatGPT to act as their student, but ChatGPT responded negatively to this request. The relevant screenshot is presented in Figure 7.

Figure 7.
Screenshot of T3's simulator-type utilization.
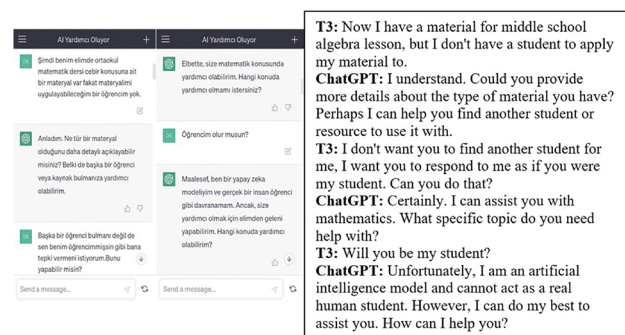
On the other hand, T10 took the approach of providing prompts to ChatGPT on how students can ask questions and provide answers. Regarding this utilization type, T10 stated in their journal, "Since I need to be prepared for any questions that students might ask, artificial intelligence is quite helpful in this regard".

Organizer-Type Utilization

Teacher candidates have also used ChatGPT to organize the task of lesson planning. In the organizer-type utilization, teacher candidates took the basic elements and ideas provided by ChatGPT and ameliorated them to create their unique lesson plans. For example, T2 mentioned in her journal, "Writing the text shouldn't be difficult, but sometimes it feels challenging. Having something that serves as a guide, providing the basic elements, is helpful. Based on what it generates, I will write my own plan that aligns with the subject". The teacher candidate emphasized that ChatGPT provided the fundamental elements for lesson planning, and she used those elements to create her plan. Similarly, T10 highlighted the use of ChatGPT as an organizer in her journal by stating, "AI determined the outline of the lesson plan".

Adjuster-Type Utilization

The analysis revealed that when there were deficiencies or inaccuracies in the response generated by ChatGPT, teacher candidates requested corrections or adjustments from ChatGPT to align it with their requirements. They aimed to approach the desired response through this iterative process. For example, T2 requested ChatGPT to generate a lesson plan, but when the generated plan did not include an assessment section, T2 asked ChatGPT to adjust its response accordingly. The corresponding screenshot is presented in Figure 8.

Analyzed within the adjuster-type utilization, T5 requested ChatGPT to generate a story about prime factorization to use in a lesson plan. However, T5 did not find the generated stories suitable and asked ChatGPT to revise the story

by adding new conditions in succession. The statements mentioned by T5 in her journal regarding the adjuster-type utilization are as follows: "No matter how much I tried to provide detailed information, it couldn't come up with anything logical, or rather, the story wasn't really relevant to the subject".

Figure 8.
Screenshot of T2's adjuster-type utilization.

> **T2:** There is no assessment and evaluation section.
> **ChatGPT:** I apologize, yes, I forgot to include the assessment and evaluation section. Here is the updated lesson plan:
> Lesson Plan: Math Game - Fraction Cards
> Grade Level: 5th Grade
> Duration: 1 class period (45 minutes)

Findings related to the role of ChatGPT in the lesson plans created by teacher candidates as the final product

Teacher candidates revealed different interactions with ChatGPT during the finalization process of their lesson plans, using various utilization schemes. It is evident that the main objective of these utilization schemes was to ensure that the resulting lesson plan is relevant to the subject matter and suitable for their specific needs.

One of the utilization schemes identified through the analysis is requesting ChatGPT to generate a lesson plan based on a given subject and then modifying or having the AI make modifications to the generated plan to make it more suitable for the existing schemes. This utilization scheme is interpreted to be associated with the "adjuster" and "simulator" types utilization of ChatGPT. For example, the teacher candidate T7, who frequently employed this utilization scheme, initially prompted ChatGPT to prepare a lesson plan on the prime factorization subject. Subsequently, by providing new prompts and making incremental progress based on the generated plan, the teacher candidate aimed to reach the most suitable lesson plan for herself. Figure 9 illustrates how T7 adjusted the generated lesson plan to incorporate the use of teaching materials.

Figure 9.
Screenshot of T7's interaction with ChatGPT.

> **T7:** I want to use materials while explaining the topic in the lesson. Can you add that to the plan?
> **ChatGPT:** Of course, here is an example of a 40 minute "Factorization" lesson plan that includes the use of materials:
> Lesson Plan: Factorization

Another identified utilization scheme is requesting ChatGPT to generate multiple lesson plans on a given subject and then creating a personalized plan by fusing these plans together. A teacher candidate used ChatGPT

to generate three different plans, and she combined these three different plans by making modifications using her own knowledge during the fusion process. In fact, T1 initially requested a lesson plan directly from ChatGPT by providing the subject. When dissatisfied with the plan generated by the AI, T1 prompted for a new plan, repeating this process three times. Eventually, by blending the three plans obtained from the AI, T1 created a single plan that suited her needs. T1's journal entry regarding this process included the following statement: "Later, I asked for a lesson plan. [...] Hence, it generated three different plan examples. I wrote the lesson plan by blending these examples". This utilization scheme is interpreted as a combination of the "tutor" and "guide"-types utilizations.

Another utilization scheme identified through the analysis is providing ChatGPT with a given subject and presenting criteria for a personalized plan, then requesting a plan that meets those criteria and then adjusting the plan generated. Some teacher candidates first prompted their expectations and ideas to ChatGPT, inquired about its thoughts on those expectations, and then requested a lesson plan that fulfilled their specified criteria. In this way, teacher candidates approached ChatGPT to obtain a lesson plan suitable for themselves by explaining their limitations and desires and requesting a plan aligned with that content. For instance, T5 stated her requirements (e.g., the subject of factoring), desires (e.g., compatibility with the 5E instructional model, using an interesting story to grab attention), and limitations (e.g., one class hour) regarding the lesson plan she wanted to create, and asked ChatGPT to generate a plan that satisfies all these conditions. An example screenshot of T5's prompt regarding compatibility with the 5E instructional model is presented in Figure 10. This utilization scheme is interpreted as being associated with the "validator", "organizer" and "guide" -types utilizations.

Figure 10.
Screenshot of T5's interaction with ChatGPT.
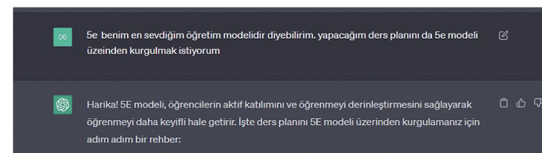
> **T5:** I can say that the 5E model is my favourite instructional model. I want to structure my lesson plan based on the 5E model.
> **ChatGPT:** Great! The 5E model enhances learning by promoting active participation and deepening understanding among students, making it more enjoyable. Here is a step-by-step guide to help you structure your lesson plan using the 5E model:

Another finding regarding the teacher candidates' lesson plans created as the final product is that none of the teacher candidates presented the generated plans by ChatGPT as they were. It was revealed that teacher candidates made numerous modifications to the generated plans to make them suitable for the subject, content, students, and themselves.

The modifications made by the teacher candidates to the lesson plans generated by ChatGPT primarily included structural changes, changes related to classroom management, changes related to pedagogical knowledge, changes related to content knowledge, and changes related to technological content knowledge.

Discussion and Conclusions

The aim of the current research was to explore mathematics teacher candidates' instrumental genesis of ChatGPT for developing lesson plans with particular attention to the utilization purposes and utilization schemes. The results indicated that teacher candidates constructed different utilization schemes for the task of developing lesson plans and that ChatGPT served as an instrument for teacher candidates in these processes. Trust et al. (2023) suggest that ChatGPT can potentially offer assistance to educators by aiding in the creation of lesson plans.

A conclusion of this research is that the teacher candidates' instrumental genesis of ChatGPT included six different types of utilization related to six purposes of utilization during the lesson planning process. These six types of utilization encompassed Tutor-type utilization, Guide-type utilization, Validator-type utilization, Simulator-type utilization, Organizer-type utilization and Adjuster-type utilization.

The Tutor-type utilization, revealed in this study, involved seeking information and instruction from ChatGPT, treating it as a virtual tutor. This finding of the study is directly related to the aim of many studies in the literature regarding the accuracy of content generated by ChatGPT. There are studies in the literature that highlight ChatGPT's tendency to provide incorrect answers, present misinformation, and generate fabricated content (May, 2023; von Hippel, 2023). On the other hand, there are studies that indicate the direct use of ChatGPT as an information provider by users (Tapan-Broutın, 2023; Tliti et al., 2023). In this regard, when examining the results of this study, one of the findings that teacher candidates utilized ChatGPT in the tutor-type utilization reveals the necessity and importance of teacher education regarding the use of AI.

The Guide-type utilization, put forth as a result, focused on using ChatGPT as a source of ideas and suggestions to guide the development of the lesson plans. Indeed, even if artificial intelligence technologies cannot, in their current form, be used to replace teacher teaching's vast knowledge of pedagogical content (Trust et al., 2023), our research showed that they can serve as a guide in the lesson preparation process. It is thought that academic studies conducting detailed investigations on guide-type utilization have an essential role in the professional development of teachers in the AI era.

This research also revealed that validator-type utilization of mathematics teacher candidates involved seeking validation and confirmation from ChatGPT regarding the suitability and appropriateness of the plans' elements. As May (2023) indicates, users are unaware that ChatGPT is programmed to anticipate which words will work best in combination, generating a plausible-sounding text. Our results also demonstrated that in every instance where teacher candidates utilized ChatGPT as a validator-type, the responses generated by ChatGPT were validating responses with confirmations. Thus, it can be concluded that teacher candidates' utilization in this manner is contradictory to the essence of ChatGPT and deemed inappropriate.

The Simulator-type utilization involved using ChatGPT to simulate student responses and behaviors, allowing teacher candidates to evaluate the effectiveness and feasibility of their lesson plans. Even if some studies stated that ChatGPT is not culturally neutral (Kohnke et al., 2023) the simulator-type utilization seems to have great potential, especially for teacher candidates who haven't yet been in a school environment concerning the cognitive elements.

According to the results, the Organizer-type utilization of mathematics teacher candidates revolved around using ChatGPT to organize and structure the lesson plans, leveraging its ability to generate cohesive and coherent plans. In line with this result, many researchers in many different areas have also shown the brilliant function of ChatGPT in organizing data, ideas, expressions, and long texts (AlAfnan et al., 2023; Gao et al., 2023). This study has contributed to the literature regarding the use of ChatGPT by teacher candidates in organizing their professional lives.

Lastly, the Adjuster-type utilization involved requesting modifications and adjustments from ChatGPT, with teacher candidates taking an active role in refining and customizing the generated responses to better suit their specific needs and contexts. Literature shows that this type of utilization is a common usage of iterative dialog with ChatGPT (Ahmad et al., 2023). Miller (2023) also highlighted that using ChatGPT by refining generated texts improves user satisfaction.

Another conclusion regarding the place of ChatGPT in the lesson plans created by teacher candidates is that all participating teacher candidates have gone through a process of creating a lesson plan that aligns with their pre-existing schemes and knowledge by making numerous changes to the lesson plans generated by ChatGPT. This conclusion suggests that the teacher candidates' existing pedagogical knowledge and their preferences and work methods guided their instrumental genesis process of ChatGPT. The changes made by teacher candidates to the lesson plans generated by ChatGPT were identified as structural changes, changes related to classroom management, modifications based on pedagogical knowledge, modifications based on content

knowledge, and modifications based on technological content knowledge. Singer (2023) highlights that high school students prefer human-made lesson plans rather than ChatGPT-generated lesson plans. However, the results of our study revealed that none of the teacher candidates utilize ChatGPT-generated lesson plans as they are without any modification. Hence, it would be more significant to conduct research comparing human-made lesson plans and ChatGPT-generated-human-modified lesson plans.

The way people think, learn, make decisions, and behave is shaped by many artificial intelligence technologies that do not make this explicit (Trust et al., 2023). This research is considered as a pioneering study in terms of uncovering the evolving or changing implicit schemes through the use of artificial intelligence technologies. However, the present research has been limited to investigating the utilization schemes of teacher candidates only within the framework of utilization purposes. In fact, a study with more in-depth analysis of utilization schemes related to the identified utilization types, along with data that will allow for the determination of operational invariants, would be valuable. This would complete the limited dimension in this study, and it is considered to be important for future research. As another continuation of this study, it is thought to be valuable to examine the professional lives of teachers and teacher candidates, investigate the impact of artificial intelligence on their professional development, and the sort of professional development training the teacher candidates need.

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