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# **Twenty Reasons Why: Investigating Use-Related Beliefs and Reasons of Preservice Teachers for (Not) Using an Intent-Based Chatbot During Lesson Planning**

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Considering the widespread belief in the potential of mobile technology to enhance core activities of teachers, like lesson planning and preparation, limited research has been conducted on the use of mobile technology to support these activities. To address this research gap, this study delved into the acceptance of an intent-based chatbot specifically designed to aid preservice teachers (n = 92) during planning tasks. Using a combination of quantitative and qualitative methods and guided by the Technology Acceptance Model (TAM), findings indicate that Perceived Usefulness was a significant predictor of Chatbot Use, while the role of Ease of Use was more nuanced. Qualitative data analysis provided valuable insights into the factors that influence chatbot adoption or nonadoption, allowing for a contextualized understanding within the TAM framework.

Lesson planning tasks constitute an integral part of teacher education and are an effective means to develop lesson planning skills in preservice teachers (König et al., 2020; Wittmann, 2021; Zazkis et al., 2009). The quality of prospective teachers' lesson plans is generally influenced by cognitive dispositions such as knowledge, as well as affective-motivational characteristics (Blömeke et al., 2015). Due to the complexity of the task, novice teachers often experience planning activities as challenging and difficult (Beckmann & Ehmke, 2023; König et al., 2020). This is particularly true when the lesson to be planned requires the integration of information and communication technologies (ICT) in a way that enhances students' learning activities. This is not surprising, as preservice teachers often report a lack of confidence in their ability to use ICT effectively as a didactic tool (Jenßen et al., 2021). It is, therefore, important to seek ways of supporting preservice teachers during planning tasks, especially when they are required to plan lessons that integrate ICT in a meaningful way.

Chatbots have the potential to reduce the complexity of planning activities (Beyer, 2022a,b), but few studies in this area have been conducted to shed light on *how* and *why* preservice teachers may use chatbots during planning tasks. This study investigates reasons why preservice teachers choose to use or not use chatbots during planning tasks, as well as their beliefs related to chatbot use.

The following section describes the theoretical background of lesson planning tasks in the context of teacher education, highlights important aspects of learning with chatbots, and briefly summarizes the Technology Acceptance Model. It is followed by a presentation of the research questions and theoretical model. Subsequently, the text details the planning task, the chatbot used in the study, and the research methods employed. The results section includes findings from the paired-sample *t*-tests, the path analysis, and the content analysis of the qualitative data. The paper concludes with a thorough discussion of these results.

## **Literature Review**

### **Complexity of Planning Tasks**

Planning skills are pivotal in the daily professional activities of teachers, as previously noted. Occasions that require the exercise of these skills are, for example, the development of learning tasks, lesson plans, teaching units, or curriculum plans (König et al., 2020; Wittmann, 2021). The planning process, influenced by the cognitive dispositions and affective-motivational characteristics of preservice teachers, involves a multitude of decisions spanning both general pedagogical and subject-specific domains. Preservice teachers are tasked with synthesizing their conceptual knowledge and the available instructional resources, aligning these with various learning goals and student needs to develop an appropriate planning product (Hammer & Ufer, 2023; König et al., 2020; Trouche et al., 2018).

With respect to the complexity of planning tasks, for example, Rich et al. (2024) found that (prospective) teachers differed in their perception of available teaching material when engaged in lesson planning activities.

For instance, they regarded different aspects of the teaching material available to them as important and differed in the ways they adapt those materials to their specific groups of learners in the classroom. Consequently, different approaches to lesson planning tasks were identified, and the results showed these approaches to have varying effectiveness, in many cases highlighting the need for guidance.

It follows that in the context of teacher education lesson planning tasks should aim to promote deliberate, criteria-based decisions rather than spontaneous ones. This includes (but is not limited to) supporting preservice teachers in successfully anticipating and addressing potential challenges their students may face when engaging with learning materials and enabling them to select resources such as working materials and ICTs that suit their students and their learning goals (Hammer & Ufer, 2023; König et al., 2020). Given the unique characteristics of each school subject, preservice teachers must reflect on subject-specific elements to make well-informed decisions during lesson planning and task allocation (Hammer & Ufer, 2023; König et al., 2020; Wittmann, 2021). A critical aspect of this process involves documenting in their written planning reports how they address key elements, such as cognitive activation, during the design and decision-making phases (König et al., 2020).

### **Substantial Learning Environments in Mathematics Teacher Education**

The following section illustrates the aforementioned complexities of planning tasks using the subject-specific example of substantial learning environments. Substantial learning environments in mathematics education adhere to a constructivist approach, providing students with a wide array of engaging mathematical activities that cater to their diverse learning needs (Wittmann, 2021). These environments comprise well-designed subtasks that are interconnected by a central subject-specific theme and can be adjusted to suit local contexts. The well-designed subtasks promote content- and process-related skills, build on previous knowledge, build up the knowledge to be acquired cumulatively, integrate meaningful contexts, and vary in their solution strategies (Wittmann, 2021).

Within the realm of mathematics teacher education, substantial learning environments offer both preservice and in-service teachers ample opportunities for exploration. This exploration may include examining the epistemological structure embedded within the learning tasks of these environments or adapting them to fit potential classroom scenarios (Nührenböcker et al., 2016).

In the context of planning processes for substantial learning environments, major challenges include identifying or creating tasks with the characteristics previously described. Furthermore, these challenges extend to focusing on concrete learning objectives and students' learning needs, integrating these elements, and adapting the original task accordingly. Subsequent steps must then include enhancing the task with appropriate support systems and planning for its specific implementation in the classroom.

Given this context, it is imperative to provide adequate support for preservice teachers during these complex activities to fully realize the potential of planning tasks in teacher education.

### **Mobile Learning With Chatbots**

The support for preservice (and in-service) teachers becomes even more critical amidst teacher shortages and the increasingly diverse backgrounds of preservice teachers' qualifications and competencies (Beyer, 2022a; Flores, 2023). However, providing intensive one-on-one support is often unfeasible due to the limited resources within teacher education systems (Beyer, 2022a). Against this broader context, the utilization of ICT has emerged as a focal point in teacher education research, offering potential solutions to these challenges.

Given the growing emphasis on ICT in teacher education, it has long been regarded as a promising approach to enhancing core teaching activities such as lesson planning and preparation (Borko et al., 2009). McKenney and Visscher (2019) among others, have highlighted the potential of ICT to

guide the processes of creating new activities or resources, or help teachers assemble and curate existing resources in ways that foster alignment between aims, learning activities, and assessment. (p. 130)

However, the anticipated potential of ICT contrasts with the slow progress of digitization in educational systems, for instance in Germany (Frailon et al., 2019). Thus, Borko et al. (2009) emphasized the conflicting dynamics that arise from the disruptive power of digitization and the intricate challenges involved in its implementation within teaching and teacher education.

It is noteworthy that a significant portion of the existing research on the use of ICT in educational contexts has focused on instructional aspects or qualifications of teachers to incorporate these technologies in the classroom effectively. A smaller body of literature has delved into the utilization of ICT for enhancing the performance and learning of (prospective) teachers (McKenney & Visscher, 2019). These studies have often revolved around e-learning and the utilization of video-based approaches. However, these formats have frequently perpetuated characteristics of face-to-face learning and failed to adequately address core activities of (preservice) teachers such as lesson planning and preparation (Beyer, 2022b).

Against this backdrop, mobile learning has garnered significant research attention in teacher education, primarily due to its potential for personalizing learning content, offering flexible access irrespective of time and location, providing adaptivity, and granting low-threshold access to information. Advancements in smartphone and other mobile device technologies have further amplified the potential benefits of mobile learning (Aubusson et al., 2009; Sánchez-Prieto et al., 2016).

The potential advantages of mobile learning for teacher education and practice were recognized early (Aubusson et al., 2009). The integration of informal learning tools, such as chatbots, into formal learning environments has emerged as a particularly promising approach (Sánchez-Prieto et al., 2016; Wollny et al., 2021). This approach proves beneficial in addressing learner heterogeneity, such as that among preservice teachers, and facilitating connections between various spaces. Wollny et al. defined a chatbot as follows:

Chatbots are digital systems that can be interacted with entirely through natural language via text or voice interfaces. They are intended to automate conversations by simulating a human conversation partner and can be integrated into software, such as online platforms, digital assistants, or be interfaced through messaging services. (p. 2)

While chatbots have proven their potential to support learners and learning outcomes in a variety of educational settings (Wollny et al., 2021; Wu & Yu, 2024), the development of chatbots as professional learning tools for (preservice) teachers is still in its early stages and the field remains relatively underresearched (Chiu et al., 2023). This underdevelopment can, at least in part, be explained by the fact, that developers of chatbots tend to lack the required knowledge and expertise to design and implement effective pedagogical strategies, leading to a misalignment between the chatbots' functionality and the overall goals and objectives of teacher education. Consequently, existing chatbots frequently prioritize assisting students while neglecting the opportunity to support (prospective) teachers. Moreover, as developers often fail to adequately consider pedagogical requirements, chatbots might not meet initial expectations (Baran, 2014; McKenney & Visscher, 2019; Sánchez-Prieto et al., 2016).

### **Technology Acceptance Model**

The affective-motivational characteristics of preservice teachers significantly influence their decision-making process when it comes to lesson planning and the integration of ICT for teaching and learning (Ertmer & Ottenbreit-Leftwich, 2010), as shown, for example, on emotions and self-efficacy beliefs in mathematics teacher education (Jensen et al., 2021, 2023). Accordingly, this paper aimed to explore preservice teachers' acceptance of using a chatbot as an aid in lesson planning activities.

The Technology Acceptance Model (TAM; Davis, 1989) is the most widely used model for examining technology acceptance (Granić & Marangunić, 2019). Numerous empirical studies have demonstrated the model's strength in predicting the rejection or adoption and continued use of innovative technologies.

The original version of TAM includes two beliefs related to usage: Perceived Ease of Use and Perceived Usefulness. Research has consistently shown that these two core variables of TAM have a strong predictive power for both the intention to use and the actual use of technology (Granić & Marangunić, 2019). Consequently, any change in

Perceived Ease of Use and Perceived Usefulness over time directly impacts the target variables (Bhattacharjee & Premkumar, 2004).

Additionally, TAM incorporates external variables that influence the core variables of the model. As the model has evolved, several external variables have been identified and empirically supported, including self-efficacy, subjective norm, computer self-efficacy, control, and perceived content quality. These expanded versions of the model are commonly referred to as TAM++ (Granić & Marangunić, 2019). A strength shared by all versions of the model is their flexibility and simplicity (Sánchez-Prieto et al., 2017).

Granić and Marangunić (2019) found that the research on TAM in educational settings from 2003 to 2018 primarily focused on e-learning technologies. Furthermore, the results were based on samples predominantly consisting of students (83%). Only a small percentage of studies (6%) addressed teachers or lecturers, and even then, the emphasis was primarily on their role as educators rather than as learners themselves (Granić & Marangunić 2019).

Current research findings related to (preservice) teachers focus on various aspects, including the impact of pedagogical and epistemological beliefs on the acceptance of technology of preservice teachers (e.g., Gurer and Akkaya 2021), the acceptance of a mobile portfolio app (e.g., Petko et al. 2023), or the use of educational robots in mathematics classroom (e.g., Alqahtani et al. 2022). In the context of mobile learning, further external factors have been identified, such as the quality of learning content, interactivity, user interface design, accessibility, and responsiveness (Granić & Marangunić 2019).

However, despite the advancements in mobile learning research, there are still notable gaps that require attention. For instance, there is a limited number of studies investigating specific mobile applications, such as educational chatbots (Chocarro et al., 2020). Moreover, participants are often surveyed early and without sufficient usage experience, leading to measurements that primarily focus on general attitudes toward mobile learning. Consequently, the findings of such studies have limited potential to reveal relevant factors and reasons for accepting or rejecting specific approaches to mobile learning (Islamoglu et al., 2021; Sánchez-Prieto et al., 2017). Furthermore, there is a scarcity of research concentrating on preservice teachers, who hold a unique position between learners and future teachers (Granić & Marangunić, 2019; Jenßen et al., 2023). Additionally, the absence of long-term intervention studies has been identified as an area that requires further investigation (Bhattacharjee & Premkumar, 2004; Granić & Marangunić, 2019; Islamoglu et al., 2021).

## **Methods**

### **Research Questions**

The aim of this study was to investigate the beliefs of preservice mathematics teachers regarding the use of a chatbot designed to support lesson planning tasks, as well as their reasons for using or not using it. The investigation was conducted within the framework of the TAM (Davis, 1989). To encourage active engagement with the chatbot, preservice

teachers utilized the chatbot in an authentic planning task as part of a teacher education course. The primary research questions were as follows:

RQ1a: How do use-related beliefs change at the intra-individual level when using the chatbot?

RQ1b: How do the use-related beliefs change at the inter-individual level when using the chatbot?

RQ1c: How do the use-related beliefs and the actual use of the chatbot affect each other during and after the lesson planning task?

RQ2: What do preservice mathematics teachers perceive as potential benefits and limitations of using chatbots for lesson planning tasks?

### **Research Model**

Building upon the theoretical framework, the current study aimed to address the research questions by testing the following hypotheses (see Figure 1). Drawing from previous research on the original TAM, as discussed in the section above, we hypothesized that Perceived Ease of Use at the first measurement point (t1) would directly influence Perceived Usefulness at t1 (H1). Similarly, we anticipated that Perceived Ease of Use at t2 would have a direct effect on Perceived Usefulness at t2 (H2). Additionally, we hypothesized that Perceived Ease of Use at t1 would directly affect Actual Use (H3), and likewise, that Perceived Usefulness at t1 would directly influence Actual Use (H4).

We also anticipated that Perceived Ease of Use at t1 would affect Perceived Ease of Use at t2 (H5) and that Perceived Usefulness at t1 would influence Perceived Usefulness at t2 (H6). Furthermore, considering the potential impact of changes in these beliefs on Actual Use (Bhattacharjee & Premkumar, 2004), we hypothesized that Actual Use would have a longitudinal direct effect on Perceived Usefulness at t2 (H7) and on Perceived Ease of Use at t2 (H8).

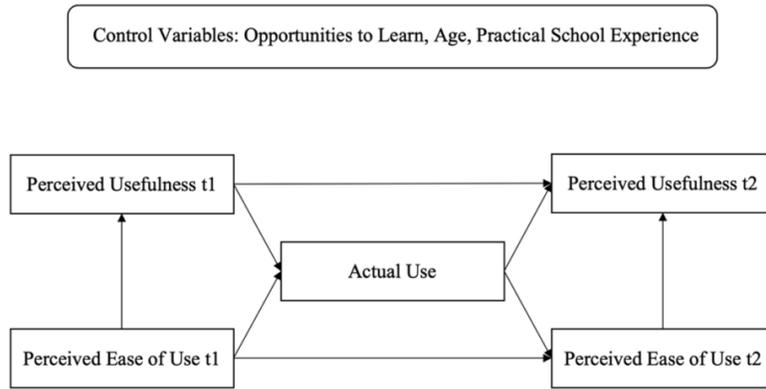
There has been considerable evidence indicating that differences in Age, Practical School Experience and Opportunities to Learn are likely to influence all examined constructs (e.g., Lin et al., 2013; Starkey, 2020). Consequently, these effects were examined while controlling for Age, Practical School Experience, and Opportunities to Learn. Additionally, all possible indirect effects were tested.

### **Planning Task**

Preservice teachers who participated in this study were assigned a planning task centered around an ICT-enhanced substantial learning environment, focusing on the various possibilities of using audio podcasts in mathematics education. The primary focus of this planning task was the integration of audio podcasts in a manner that supported students'

mathematics learning activities, based on the framework developed by Schreiber & Klose (2017).

**Figure 1**  
*Research Model*



*Note.*  $t_i - i$  indicates measurement occasion.

Various approaches were considered for achieving this goal: Students could create their own audio podcasts on a mathematical topic or listen to preexisting podcasts before engaging in related subtasks. Preservice teachers were given the autonomy to choose their preferred approach for developing the substantial learning environment, while also being provided with a description of a sample learning group for which they were required to plan. This group represented a typical group of students with a variety of backgrounds and learning needs that needed to be addressed.

Within this planning task, preservice teachers were required to define an overall learning goal for the substantial learning environment; research, adapt, or create learning activities; clarify how the audio podcasts aligned with their students' learning goals; arrange the learning activities in an appropriate sequence; and anticipate and address potential challenges in the students' learning pathways. To support these complex and interdependent activities in situ and in a timely manner, a chatbot was developed.

### **Materials: Chatbot Justus**

As highlighted earlier, mobile learning with chatbots has been recognized for its significant potential in supporting preservice teachers, irrespective of time and location, providing adaptivity, and granting low-threshold access to information. This potential is especially important when other resources to support preservice teachers are not available in the same manner. However, due to the limited research and development in this specific area, no existing chatbot suited to assist preservice teachers with lesson planning could be identified. Therefore, a design-based research

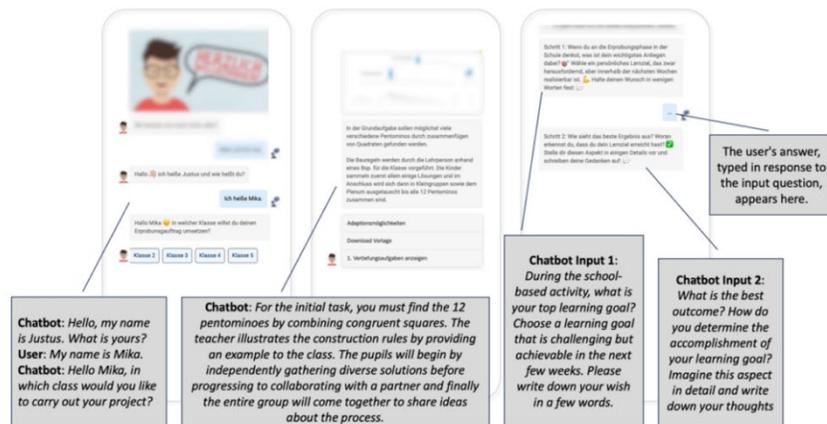
approach was chosen to develop and iteratively improve a chatbot with the intended functionality (Beyer, 2022a,b; Beyer & Arndt, 2024).

The primary goal of the chatbot has been to provide prospective teachers with a prestructured approach to lesson planning in mathematics. To this end, the chatbot was designed to promote active and independent exploration of the mathematical content to be taught in class, to support the search for appropriate learning materials, to guide the process of adapting available exercises to a specific group of learners and to facilitate the practical use of previously acquired pedagogical and content knowledge (Beyer, 2022b; Beyer & Arndt, 2024).

Despite the recent surge in popularity of generative models (e.g., Trust et al., 2023), we endorse the use of a retrieval- or intent-based model with preprepared responses tailored to the specific educational purpose of supporting preservice teachers during lesson planning. This approach ensures that the chatbot's output is accurate and eliminates the possibility of so-called hallucinations associated with generative models (Adamopoulou & Moussiades, 2020). Additionally, intent-based chatbots have a predefined scope, allowing them to provide focused support for selected aspects of the planning process, thereby enhancing control over learning goals for preservice teachers (Wu et al., 2020). Depending on the user intention and specific feature of the chatbot, the interaction may either be user driven, where users have the liberty to respond by natural language input, or chatbot driven, where users are restricted to predefined conversational prompts (e.g., buttons; Beyer & Arndt, 2024; Raunig, 2021).

The developed chatbot, named Justus, provides four key features: an Introductory Dialogue, a Planning Tool, Recommended Educational Materials and Hints for Lesson Planning.

**Figure 2**  
*Overview of Some of the Chatbot's Key Features*



Note. Refer to Beyer & Arndt (2024) for a full description of the general characteristics of the chatbot features, workflows, and more examples of content.

The Introductory Dialogue serves to familiarize users with the system and provides an overview of its features (Example located on the left-hand side of Figure 2). The Planning Tool utilizes a combination of mental contrasting, involving a comparison between the current reality and desired future outcomes and implementation intentions, comprising specific if-then plans to overcome potential obstacles to establish early commitment to goals (see Oettingen & Gollwitzer, 2010). This feature could be used by preservice teachers to organize the planning process from the outset and to become aware of the affordances associated with it (Example located on the right-hand side of Figure 2). The Recommended Educational Materials explain and elaborate on the theoretical background of the ICT-enhanced substantial learning environment, which participants were asked to plan with.

The material is supplemented by notes on lesson organization, mathematical and didactical background, and a task-specific adaptation guide (Example depicted in the center of Figure 2). This feature could be used by preservice teachers to revisit aspects covered in their teacher education course at the start of the planning process or to bolster a specific decision pertaining to audio podcasts in mathematics education as they engage in planning. Quick selection options (e.g., buttons) enable users to utilize this feature as needed. The Hints for Lesson Planning offer various prompts to guide and assist general lesson planning activities. This feature could be utilized by preservice teachers to discern which aspects need to be included in a written planning report or to recall how a learning goal can be formulated.

## Instruments

A standardized paper-and-pencil questionnaire was used to assess the constructs. The preservice mathematics teachers interacted with the chatbot for 1 month after which data was collected at two measurement time points. This approach was implemented to mitigate potential novelty effects that could influence results.

The items measuring Perceived Usefulness (four items), such as “Using Justus improves how I plan lessons in mathematics,” and Perceived Ease of Use (four items), such as “I find Justus easy to use,” were adapted from Venkatesch & Davis (2000) and Sanchez-Prieto et al. (2016) to align with the context of the current study. Participants were asked to indicate the extent to which they agreed with each statement. The items were rated on a 7-point scale, ranging from 1 (*strongly disagree*) to 7 (*fully agree*). To assess the reliability of the scales, Cronbach’s alpha was calculated (Cronbach, 1951). The reliability of the scales in the present application can be considered good: Perceived Usefulness  $t_1$  Cronbach’s  $\alpha = .98$ , Perceived Ease of Use  $t_1$  Cronbach’s  $\alpha = .87$ , Perceived Usefulness  $t_2$  Cronbach’s  $\alpha = .96$  and Perceived Ease of Use  $t_2$  Cronbach’s  $\alpha = .89$ .

Additionally, participants were asked to rate their Actual Use of the chatbot on a 5-point scale ranging from 1 (*not at all*) to 5 (*to a great extent*). They were also queried about their Opportunities to Learn using the same 5-point scale ranging from 1 (*not at all*) to 5 (*to a great extent*). Furthermore, two open-ended questions were included to gather insights

into preservice mathematics teachers' reasons for choosing to use or not use the chatbot for the planning task.

## Sample

A total of 92 preservice mathematics primary school teachers were included in the analysis. Participants were recruited from a Primary Education Teacher Master's degree program. The majority of participants was female (68% female, 20% male, 2% diverse). For descriptive statistics on the sample, see Table 1.

**Table 1**  
*Descriptive Statistics Participants*

Category	Min	Max	M	SD
Age	21	47	29.14	7.17
Semester	2	10	2.5	1.36
OTL	0	3	1.39	0.77
Practical School Experience	0	5	0.55	1.03
<i>Note.</i> $n = 92$ ; OTL = opportunities to learn how to integrate ICT into classroom activities.				

## Data Analysis

### Quantitative Analysis

To address Research Question 1a, which focuses on the intra-individual change of perceived usefulness and perceived ease of use during the use of the chatbot, paired  $t$ -tests were conducted to compare the mean differences between  $t_1$  and  $t_2$ . Prior to the analysis, the dataset was examined for outliers and normal distribution of each variable, as these are important requirements for conducting  $t$ -tests. It is worth noting, however, that violating the assumption of normal distribution does not have a detrimental effect on the results when the sample size is greater than 30 (Stone, 2010). Research Question 1b and 1c were examined by applying path analyses (Cohen et al., 2003). Path analyses allow for the investigation of variables that serve as both independent and dependent variables, as is the case in our theoretical model. Common fit indices were used to evaluate the fit of the model (Hu & Bentler, 1999). Additionally, we tested for randomness of missing values. Little's (1988) test indicated that missing values did not exhibit systematic patterns ( $\chi^2 = 6.282$ ,  $df = 6$ ,  $p = .39$ ).

### Qualitative Analysis

The second phase of our empirical analysis involved conducting a content analysis (Kuckartz, 2019) on the responses of prospective mathematics teachers to open-ended questions regarding their experiences with the chatbot. The analysis aimed to gain insights into the reasons behind the use or nonuse of the chatbot. The main categories for analysis were derived from existing literature (e.g., Perceived Usefulness, Perceived Ease of Use,

and Control) and expanded upon inductively, based on the main themes identified in the data. The resulting coding frame was independently tested on a sample and collaboratively refined. The final coding frame is presented in tables 2 and 3. Subsequently, coding instructions were formulated, and we independently conducted full coding using MaxQDA.

To assess the agreement between coders in coding the same data, we calculated the intercoder reliability (O'Connor & Joffe, 2020). By utilizing Kappa (Brennan & Prediger, 1981) to evaluate agreement on 95% of the code segments, the coding frame analysis yielded  $K_n = .78$  for reasons for using the chatbot and  $K_n = .79$  for reasons against using the chatbot. At the category level, the Kappa values for categories capturing reasons for using the chatbot ranged from  $Min = .33$  to  $Max = 1$  with  $Mdn = .73$ . Similarly, the Kappa values for categories capturing reasons against using the chatbot ranged from  $Min = .26$  to  $Max = 1$  with  $Mdn = .74$ . In a subsequent step of data analysis, divergent results were reconciled through consensus (O'Connor & Joffe, 2020; Schreier, 2012).

## Results

### Paired-Sample *t*-Test

#### *Perceived Usefulness*

There were 56 complete data sets. No outliers were detected in the data. The differences between the pre and post scores were found to deviate from a normal distribution, as indicated by the Shapiro-Wilk test ( $p < .001$ ). There was no significance difference in scores 6 weeks after first using the chatbot,  $t(55) = -.50, p = .62, d = .07 [-.2; .33]$ .

#### *Perceived Ease of Use*

There were 56 complete data sets. No outliers were detected in the data. The differences between the pre and post scores were found to deviate from a normal distribution, as indicated by the Shapiro-Wilk test ( $p < .05$ ). Scores were significantly lower 6 weeks after first using the chatbot,  $t(55) = -3.7, p < .001, d = .49 [.22; .77]$ .

**Table 2**

*Descriptive Statistics Variables*

	<i>n</i>	<i>Min</i>	<i>Max</i>	<i>M</i>	<i>SD</i>
Actual Use	79	0	4	1,57	1,05
PUt1	78	1	7	4,08	1,39
PUt2	58	1	7	3,88	1,34
PEOUt1	78	1	7	4,59	1,31
PEOUt2	58	1	7	3,94	1,29

*Note.* PU = Perceived Usefulness, PEOU = Perceived Ease of Use.

## Path Analysis

### Model Fit

The fit indices suggested that the model fits the data well ( $\chi^2(3) = 6.744, p = 0.56, CFI = 1.00, TLI = 1.00, SRMR = .05, RMSEA = 0.00$  with 90% CI [0.00; 0.11]).

### Direct Effects

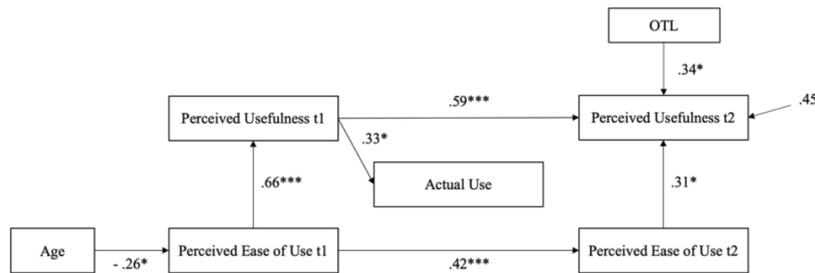
Consistent with our hypotheses, Perceived Ease of Use  $t_1$  showed a significant positive effect on Perceived Usefulness  $t_1$  ( $\beta = .66, p < .001$ ) as well as on Perceived Ease of Use  $t_2$  ( $\beta = .42, p < .001$ ). Perceived Usefulness  $t_1$  had a significant positive effect on Perceived Usefulness  $t_2$  ( $\beta = .59, p < .001$ ) and on Actual Use ( $\beta = .33, p < .05$ ). Furthermore, Perceived Ease of Use  $t_2$  had a significant positive effect on Perceived Usefulness  $t_2$  ( $\beta = .31, p < .05$ ) (see Figure 3).

Additionally, Opportunities to Learn showed a significant positive effect on Perceived Usefulness  $t_2$  ( $\beta = .34, p < .05$ ) while Age had a significant negative effect on Perceived Ease of Use  $t_1$  ( $\beta = -.26, p < .05$ ).

### Indirect Effects

None of the indirect effects were found to be significant (see [appendix](#)).

**Figure 3**  
Direct Effects Found to be Significant



Note.  $t_i - i$  indicates measurement occasion; OTL = Opportunities to Learn; \* =  $p < .05$ ; \*\*\* =  $p < .001$ .

### Percentage of Variance Explained in the Model

The relationships proposed in the model explain 43% of the variance in Perceived Usefulness  $t_1$ , 55% of the variance in Perceived Usefulness  $t_2$ , 42% of the variance in Perceived Ease of Use  $t_2$ , and 15% of the variance in Actual Use.

### Content Analysis of Qualitative Data

The final data set for analysis consisted of 176 coded segments from 78 preservice mathematics teachers. Example quotations for this manuscript were translated into English by the first author. To ensure the accuracy and fidelity of the translation, we collaboratively reviewed the translations, meticulously preserving the original meaning of the preservice teachers' statements.

**Table 3**  
*Coding Frame Reasons to Use With Descriptions and Example Quotes*

Category	Description	Example quote
<b>Usefulness Aspects</b>		
- General Usefulness	Statements indicating the overall usefulness of the chatbot in the planning process.	"Justus [the chatbot] helped me." (P76)
- Useful for planning and structuring	Statements indicating the usefulness of the chatbot in assisting with the preparation and structuring of the planning process.	"[It] helped to structure planning." (P44)
- Useful for conceptual knowledge acquisition	Statements indicating the chatbot's usefulness in addressing conceptual knowledge challenges.	"There was a key word that I was unclear on, and I wanted it explained to me." (P56)
- Useful support	Statements indicating the chatbot's usefulness as an aid in the planning process.	"[It] provided suggestions on supplementary reading." (P77)
- Useful examples	Statements indicating the use of the chatbot as a valuable resource for accessing examples during the planning process.	"[It offered] potential examples relevant to my topic." (P85)
- Useful for regulation of unpleasant emotions	Statements indicating the usefulness of the chatbot in assisting individuals in managing and coping with unpleasant emotions during the planning process	"[The chatbot alleviated my] fear of forgetting something" (P67)
- Useful for activation	Statements suggesting the usefulness of using the chatbot to initiate the planning process or its sub-steps.	"It has been a great help in generating ideas." (P15)
<b>Perceived Ease of Use</b>	Statements indicating a low level of effort required to use the chatbot.	"I found it convenient to get information easily." (P65)
<b>Emotional-motivational Use-Aspects</b>	Statements indicating emotional or motivational aspects of using the chatbot to perform the planning task.	"I was curious to see what [the chatbot] could do, and what paths it would take." (P22)
<b>Mandatory/Recommendation</b>	Statements indicating that the use of the chatbot is perceived as expected or mandatory in the context of the planning task.	"Course requirements" (P88)

### **Reasons to Use the Chatbot**

The primary reason for using the chatbot during planning tasks was Perceived Usefulness, which was the most reported category (69 coded segments). Participants identified specific aspects of usefulness that they found beneficial at the beginning and during the planning process. Initially, the chatbot was considered useful for inspiration, planning, and structuring the entire process, as well as offering task examples. During the planning stage, preservice mathematics teachers found the chatbot particularly useful for regulating unpleasant emotions like fear and uncertainty, and for providing support in addressing specific aspects of the planning process.

Additionally, participants perceived the chatbot as useful in enhancing their conceptual understanding. Emotional and motivational factors played a crucial role in motivating preservice teachers to engage with the chatbot, with 9% expressing curiosity or interest in its capabilities. Although Ease of Use was not a primary concern for most participants, it still influenced their utilization of the chatbot. Furthermore, while the use of the chatbot was voluntary, some preservice teachers reported a sense of obligation to use it. See Table 3 for example quotations.

### **Reasons for Nonuse of Chatbot**

Reasons for nonuse were related to Perceived Nonusefulness. Three aspects of nonusefulness were identified: decline in usefulness, lack of usefulness, and prospective usefulness. Participants who mentioned a decline in usefulness expressed that the information provided was not new or useful or that the chatbot failed to provide additional information in response to their queries. Those who cited lack of usefulness believed that they did not require additional assistance from the chatbot because the planning process was already clear to them or because they were utilizing other resources. Some participants acknowledged the potential of the chatbot to enhance their planning skills in the future but said that presently they do not perceive it as useful. Nonuse was also influenced by a Lack of Ease of Use and a Lack of Control. Technical problems and user interface issues were commonly reported as barriers to ease of use. Lack of control primarily referred to challenges in human-machine interaction, the need for guidance during the planning process, and difficulties in using the chatbot in a goal-oriented manner due to time constraints or technological limitations. Chatbot personality and emotional-motivational aspects played a relatively minor role in nonuse (See Table 4 for example quotations).

### **Group Comparisons**

Based on the analyzed data, we performed qualitative group comparisons. We compared groups based on their usage frequency and changes in perceived usefulness between measurement points. However, these analyses did not reveal any significant differences in the distribution of reasons for using or not using the chatbot during the planning task across the groups.

**Table 4**  
*Coding Frame Reasons to Nonuse With Descriptions and Example Quotes*

Category	Description	Example quote
<b>Nonusefulness Aspects</b>		
-Decline in usefulness	Statements indicating a decrease in the perceived usefulness of the chatbot while working on the planning task.	"I had the feeling that, after 15 minutes, I had absorbed all the available information." (P28)
-Lack of usefulness	Statements indicating that the chatbot is perceived as not useful or ineffective in performing the planning task.	"I didn't need it. I didn't think it was necessary." (P48)
-Prospective usefulness	Statements indicating the potential usefulness of the chatbot in the future, while also expressing that it is presently not perceived as useful.	"My impression was that the chatbot could be useful for pre-service teachers who already have experience in designing lesson plans." (P19)
<b>Control</b>		
-Deficiency in Interaction	Statements indicating a perceived deficiency of the chatbot to react and interact appropriately and as expected.	"Unfortunately, we didn't connect." (P2)
-Need for Guidance	Statements expressing the need for a guidance or assistance in the planning process or in using the chatbot.	"[I was hoping for] a structured overview or schedule [that shows] where I should start, how I should proceed, etc." (P59)
-Temporal Constraints	Statements indicating temporal constraints on chatbot usage including time restrictions and workload.	"Lack of time." (P52)
- Lack of Ability	Statements indicating (perceived) inability to use the chatbot.	"I wasn't able to get it to work." (P3)
- Lacking Ease of Use	Statements indicating high perceived effort associated with using the chatbot.	"It is often unclear, how to operate [the chatbot]." (P69)
<b>Emotional and Motivational Aspects of Nonuse</b>	Statements indicating emotional or motivational aspects of not using the chatbot.	"Lack of interest." (P9)
<b>Chatbot-Personality</b>	Statements about the non-use of the chatbot in relation to its personality or perceived characteristics.	"Unpleasant name." (P2)

## Discussion

The study provides insights into the reasons for (not) using a chatbot designed to support preservice mathematics teachers during lesson planning. After 1 month of interaction with the chatbot, data were collected at two measurement time points using a standardized paper-and-pencil questionnaire. To address Research Question 1a, paired *t*-tests

were conducted to compare mean differences between  $t_1$  and  $t_2$ . Research Questions 1b and 1c were examined through path analyses. Additionally, the empirical analysis involved conducting a content analysis of the responses from preservice mathematics teachers to open-ended questions about their experiences with the chatbot.

The findings indicate that the core variables of TAM (Davis, 1989) and their impact were validated in this study concerning the use of chatbots in the lesson planning context. Unlike Ease of Use, Perceived Usefulness has proven to be a crucial influencing factor affecting the adoption or rejection of the chatbot, as indicated by both quantitative and qualitative analysis. However, the role of Ease of Use appears ambiguous. When preservice mathematics teachers perceive that using the chatbot required little effort, it did not necessarily lead to increased Actual Use. Simultaneously, qualitative evaluations highlight that a perceived Lack of Ease of Use contributed to the decision not to use the chatbot. This may be partly because preservice teachers were better accustomed to using ICT for simple than for complex tasks, which might have affected the adoption of chatbots for planning tasks. Moreover, participants may have felt a loss of control over the technology while using the chatbot.

One perspective to consider regarding these results is the complexity of effects that was uncovered in the qualitative analysis regarding the adoption or rejection of the chatbot by preservice teachers (also see Wu & Yu, 2024). Factors like novelty effects or a lack of familiarity with chatbots could contribute to explaining the complex structure of use-related beliefs and challenge the assumption that the widespread usage of mobile messaging apps simplifies familiarization with chatbots (Hobert & Meyer von Wolff, 2019). Additionally, facets of professional competence, such as knowledge or situation-specific skills (Blömeke et al., 2015) that were not included in this study, may potentially act as intermediaries between affective-motivational variables and actual behavior and help explain adoption and nonadoption of the chatbot.

The quantitative analysis revealed that use-related beliefs were relatively stable over time, both within individuals and across different individuals. Notably, Actual Use did not significantly influence use-related beliefs within the model, suggesting that these beliefs were core beliefs of preservice mathematics teachers, resistant to change even if recently formed. This finding aligns with general research on the stability of preservice mathematics teachers' beliefs (Liljedahl et al., 2012) and the predictive power of initial use-related beliefs (Sprenger & Schwaninger, 2023). Given this context, the question arises as to what are the relevant factors and interventions that might change the use-related beliefs of preservice mathematics teachers in this context. To facilitate understanding, it may be beneficial to examine the categories that were identified in the qualitative analysis of the reasons for both use and nonuse.

The study identified reasons for use and nonuse of the chatbot in lesson planning tasks. The decision of preservice mathematics teachers to use or not use the chatbot primarily depended on their perception of its usefulness or lack thereof. Perceived Usefulness was particularly important in situations where the lack of in-person support had the potential to disrupt or halt the ongoing planning process. In contrast to

tasks carried out during face-to-face sessions, where students have immediate access to lecturers or peers for assistance, planning tasks are often tackled remotely and at individually chosen times. The chatbot was found to be useful in facilitating quick searches for specific information, such as explanations or examples, and in aiding the structuring of the lesson planning process.

On the other hand, some participants chose not to use the chatbot because they believed other sources were more productive before or during the planning process or simply because they did not perceive a need to utilize the chatbot. It is worth considering whether preservice mathematics teachers genuinely had no need for the tool or whether they were resistant to changing their established practices. Furthermore, some participants reported that the usefulness of the chatbot diminished during the planning process, raising the question of whether perceived usefulness could be improved by expanding the material available or emphasizing strategies for effectively using the information available.

The remaining reasons for using or not using the chatbot can also be situated within the context of the TAM (Davis, 1989). Previous studies have identified some of these reasons as external factors. However, it is important to note that these studies primarily examined different tools or usage contexts. The present study aimed to contribute by highlighting the design features that should be taken into consideration specifically for chatbots in the context of planning tasks.

Considering the practical implications of this study, it serves as a proof of concept (Bakker, 2018) demonstrating a potential application of chatbots in supporting preservice teachers. The Planning Tool, based on mental contrasting and implementation intentions (Oettingen & Gollwitzer, 2010), proved helpful in organizing the overall process. It was found that designing the learning materials in an action-oriented manner is beneficial. The Recommended Educational Materials feature was designed to present didactic principles and mathematical content in a concise manner through prompts. The content was sequenced into subtasks with corresponding interactive quick selection options, allowing preservice mathematics teachers to consume it selectively or linearly in a prestructured manner. The study showed these design features to be effective. Furthermore, the results highlight, that teacher educators should provide prospective teachers with compelling arguments that emphasize the usefulness of the chatbot to support planning tasks to increase the likelihood of adoption during lesson planning tasks.

The results of the study should be interpreted in light of their limitations. The small sample size and the study's confinement to a single university context raise concerns about the external validity of the findings. It's worth noting that the sample consisted of master's students. Different groups, such as teachers in preparation, may have different beliefs and assessments about the reasons for using the chatbot. Additionally, longitudinal studies inherently face threats to internal validity.

Despite these limitations, longitudinal studies provide insight into the stability of beliefs and could be a foundation for future research. Furthermore, the aforementioned lack of data on preservice teachers' knowledge could also be an aspect for future research. A follow-up study

could effectively explore the role of knowledge in chatbot adoption, complementing the results on affective-motivational variables and adoption from the present study. Another perspective for a follow-up study could be to investigate the long-term effects of teacher education courses that incorporate chatbots on the sustainability of chatbot integration, influences on teachers' lesson planning practices, student learning outcomes, or whether teachers who have been trained with chatbots express particular professional development needs or preferences over time.

### Disclosure Statement

There are no competing interests to declare.

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### Appendix Indirect Effects

	<b><math>\beta</math></b>	<b><math>p</math></b>
PEOU <sub>t1</sub> on PEOU <sub>t2</sub> (mediator: PU <sub>t1</sub> )	.19	.06
PEOU <sub>t1</sub> on PEOU <sub>t2</sub> (mediator: Use)	.001	.89
PEOU <sub>t1</sub> on PEOU <sub>t2</sub> (mediator: PU <sub>t1</sub> and Use)	.003	.89
PU <sub>t1</sub> on PU <sub>t2</sub> (mediator: PEOU <sub>t2</sub> )	.09	.13
PU <sub>t1</sub> on PU <sub>t2</sub> (mediator: Use)	.03	.41
PU <sub>t1</sub> on PU <sub>t2</sub> (mediator: PEOU <sub>t2</sub> and Use)	.002	.89
<i>Note.</i> PU = Perceived Usefulness, PEOU = Perceived Ease of Use, $t_i - i$ indicates measurement occasion.		