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# Preservice computer science teachers' beliefs, motivational orientations, and teaching practices

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**ABSTRACT**

This multiple case study sought to examine preservice computer science teachers' beliefs, motivational orientations, and teaching practices, as currently, they remain to be adequately researched. Eight participants were selected via maximum variation sampling for this study of trainee teachers during their first practicums in Turkey. Trainee teachers were observed in the natural setting of a computer science classroom during their teaching try-outs. Interviews were conducted with them on either side of their pre-planned lessons. Results show that teacher efficacy, self-efficacy related to using and integrating technology, and classroom management influenced participants' teaching practices. Further research is necessary to examine the consistencies and contradictions between preservice CS teachers' beliefs and practices and how these change during field experience and exemplify good practice for the benefit of CS education.

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Teacher beliefs; teaching practice; motivational orientations; computer science teacher education; multiple case study

## Introduction

Technology powerfully shapes the world we live in and is an essential requirement for innovation and productivity (Webb et al. 2017). Societies need workers who are educated computationally (Gal-Ezer and Stephenson 2010; Yadav and Korb 2012), and therefore, it is crucial to prepare students for the technologically rich age (Yadav et al. 2016). Individuals are supposed to support their learning, construct knowledge, design innovations, think computationally, and communicate and collaborate creatively using ICT (ISTE 2016). Training individuals with these standards requires effective and efficient technology integration (Kabakci Yurdakul 2011). The need to prepare students for the computing-based world led to introducing computer science to the primary and secondary education curriculum (Giannakos et al. 2014; Hubbard and D'Silva 2018; Yadav et al. 2016). Computer science (CS) education not only equips students with technology skills but also provides them with the knowledge and skills needed for future technology tools (Gal-Ezer and Stephenson 2010) and improves students' critical and analytical thinking and problem-solving skills (Dağ 2019). CS education encourages students to be

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technology developers instead of consumers of technology (Gal-Ezer and Stephenson 2010; Webb et al. 2017). CS education's importance makes what CS teachers believe and how they teach attractive since teachers' beliefs and teaching practices have been a focus of interest for a long time (Kordaki 2013; Levin and Wadmany 2006; Palak and Walls 2009).

It is well known that teacher beliefs have a crucial effect on their teaching practices and instructional decisions (Abbitt 2011; Kagan 1992; Pajares 1992). Kim et al. (2013) concluded that teachers' beliefs about the nature of knowledge and learning, beliefs about effective ways of teaching, and teachers' technology integration were significantly correlated to each other. However, the relationship between teacher beliefs and technology is unclear. There is a gap between teacher intentions (beliefs) and technology use (Ottenbreit-Leftwich et al. 2018). Unpacking the beliefs and teaching practices of CS teachers will help institutions to understand better the challenges these teachers face and what can be done to broaden access to CS education (Giannakos et al. 2014). It is therefore important to know how teachers' beliefs about teaching and learning CS influence the quality of their work.

## *Theoretical frameworks*

Most research on technology use focused on teacher beliefs and teaching practices (Ertmer et al. 2012; Kordaki 2013; Levin and Wadmany 2006; Palak and Walls 2009). Pajares (1992) asserted that teacher beliefs are as influential as teacher knowledge. In other words, beliefs about technology integration may be as effective as knowledge of technology integration. The most commonly used framework investigating technology use is Technology Acceptance Model (TAM), developed by Davis (1989). TAM reveals the factors influencing teachers' technology use. Researchers employing TAM found that teachers with student-centred teaching beliefs and high teaching efficacy beliefs are more likely to accept technology (Kiziltepe and Kartal 2022; Gurer and Akkaya 2021; Huang and Teo 2021; Teo, Huang, and Hoi 2018).

Teachers' beliefs about technology also give an insight into how teachers tend to use technology (Abbitt 2011). Teachers' different uses of technology depend on their beliefs about teaching and learning regardless of technology use (Kim et al. 2013) and their beliefs about how technology promotes students' learning (Petko 2012). Computer science teachers have the knowledge of technology, but it is not enough to develop appropriate learning environments with technology. They also should know how to integrate technology (Dağ 2019; Doukakis and Papalaskari 2019). Teaching computer sciences requires engaging students in higher-order thinking skills and applying technical knowledge to solve problems (Jiménez Toledo, Collazos, and Ortega 2021).

The present study was conducted in Turkey using the framework that includes teacher beliefs and motivational orientations developed for CS teachers by Bender et al. (2016). Teacher beliefs comprise their notions about the subject of computer science and its teaching and learning. Beliefs about CS in this study refer to the beliefs about the perceived value of technology. Teachers' perceived values about the technology for student learning enhance teachers' perceptions about the effectiveness of technology (Hsu 2016). Besides, there is a relationship between teachers' conceptions of teaching and their decisions about technology integration. Teachers with student-centred beliefs tend to provide unstructured and open-ended learning environments to integrate technology, and teachers with teacher-centred beliefs tend to create structured and direct learning environments (Kim et al. 2013). The technological tools used in course designs that provide students with ample opportunities to participate, collaborate, and communicate with peers promote the quality of the teaching-learning process (Collazos et al. 2021).

Teachers' beliefs about teaching computer science centred on making students realise the nature, challenges, and benefits of CS so as to increase their interest and motivations (Sadik, Ottenbreit-Leftwich, and Brush 2020) and make them realise the connection between their daily lives and CS concepts (Tew, Fowler, and Guzdial 2005). Connecting CS concepts to daily lives has a vital role in CS classrooms. It is seen that professors have reported analogies related to daily activities such as sales, housework, and cooking recipes in their teaching practices. Such examples promote their abstraction of fundamental concepts in computer science (Jiménez Toledo, Collazos, and Ortega 2021).

Motivational orientations consist of enthusiasm and efficacy regarding specific tasks in CS and the profession as a CS teacher. Enthusiasm is an essential requirement that refers to an interest in rapidly occurring technical innovations and the willingness to stay up to date (Bender et al. 2016). On the other hand, self-efficacy beliefs, pedagogical beliefs, and confidence in technology are the factors that affect teachers' ways of teaching with technology (Ertmer and Ottenbreit-Leftwich 2010). Self-efficacy is associated with teachers' technology use (Ertmer and Ottenbreit-Leftwich 2010; Ottenbreit-Leftwich et al. 2018; Pajares 2002), and its absence may hinder the successful integration of technology (Ottenbreit-Leftwich et al. 2018). Therefore, we investigated technology self-efficacy, CS teacher efficacy, and self-efficacy for technology integration.

On the other hand, teacher efficacy has been defined as teachers' confidence about positively influencing their students' ways of learning and is also related to teacher enthusiasm to employ innovative approaches (Tschannen-Moran and Hoy 2001). Innovative techniques used in computer science education, such as analogies, would promote the teaching-learning process, improving students' creativity, attitudes, skills, and imagination (Jiménez Toledo, Collazos, and Ortega 2021). Besides, teachers with a high level of efficacy are more likely to make their courses more engaging (Swars 2005), which is an essential component in sustaining student participation. Facilitating discourse in the classroom and encouraging students to ask questions and propose new ideas is a valuable avenue of effective teaching. Collazos et al. (2021) reported that these aspects are absent from online courses, making it difficult to retain students' attention.

Teacher efficacy has a close relationship with technology integration self-efficacy beliefs (Bender et al. 2016). Self-efficacy beliefs for technology integration describe how teachers create learning environments to use technology in meaningful ways and how much effort they will spend to integrate technology effectively (Wang, Ertmer, and Newby 2004). Figure 1 demonstrates the theoretical frameworks used in this study.

The other framework used to explore the preservice teachers' teaching practices is proposed by Kordaki (2013). She investigated high school CS teachers' teaching practices in terms of (i) investigation of previous knowledge, (ii) handling of students' mistakes, (iii) kind of learning activities used, (iv) kind of communication that took place, and (v) student involvement (Kordaki 2013, p.146). The author suggested that these issues are closely associated with the social and constructivist views of learning suggested by Vygotsky and Cole (1978).

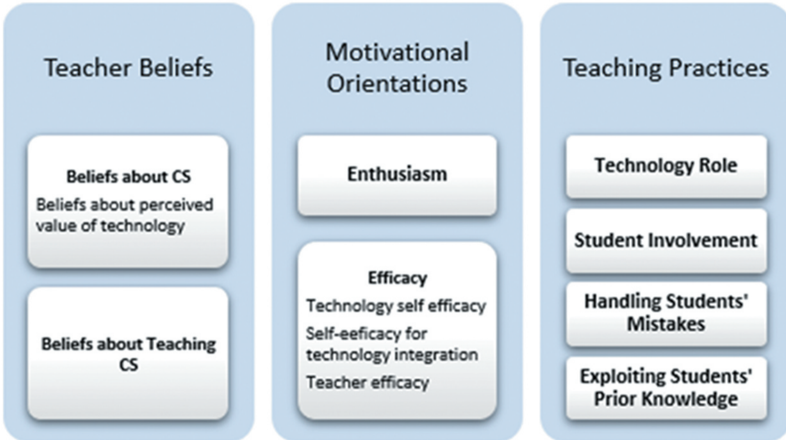


**Figure 1. Theoretical frameworks used in the study (adapted from** Bender et al. 2016; Hsu 2016; Kordaki 2013).

## CS Education in Turkey

4-year bachelor's degree to be appointed as CS teachers in Turkey. Since 1998, teacher preparation programmes have included a department of Computer Education and Instructional Technologies (CEIT). Preservice CS teachers take courses related to technologies (such as algorithms, programming) and teaching CS (such as information technologies in education, methods of teaching programming). They enrol in a two-section method course in their third year. The method course informs preservice teachers about teaching CS to middle-grade students. Preservice teachers are assigned to schools for field experience and student teaching in the teacher education programme's final year. They observe students, teachers, and administrators and then teach CS concepts with their cooperating teachers. This department's graduates are called computer teachers or information technology (IT) teachers. In schools, "Information Technologies and Software" has become a mandatory course for fifth and sixth graders and an elective course in the seventh and eighth grades. This course consists of information technologies, ethics and security, communication, research, collaboration, problem-solving, and programming. Besides, information technology teachers are expected to support other teachers from different subject areas to integrate technology into their teaching. We use the term preservice CS teacher for this study to ensure consistency with the related literature.

## Research related to CS teacher education

CS teachers should have technological, pedagogical, and methodological skills to sustain student engagement in CS activities (Gal-Ezer and Stephenson 2010). The lack of teachers with sufficient subject matter (computer science) knowledge and recruiting non-specialist teachers for CS education is a crucial barrier to improving the enthusiasm for CS (Yadav et al. 2016). Therefore, the knowledge needed to teach CS has attracted considerable attention from multiple researchers (Bender et al. 2016; Giannakos et al. 2014; Hubbard 2018; Hubbard and D'Silva 2018; Yadav et al. 2016).

The importance of technical knowledge has also become prominent in emergency remote education due to the pandemic lockdown, remarking the necessity of preparing technologically knowledgeable preservice teachers (Collazos et al. 2021). Bender et al. (2016) performed interviews with experts to identify and formulate teacher beliefs and motivational orientations for CS teacher education. Yadav et al. (2016) investigated CS teachers' perspectives about teaching computer CS, the challenges they faced in the classroom, and the support they need to increase teaching quality.

Additionally, Sadik, Ottenbreit-Leftwich, and Brush (2020) categorised CS teachers' challenges as knowledge and skills, curricular needs, contextual needs, and pedagogical needs. Knowledge and skills need mostly refer to the limited content knowledge and skills of teachers, especially from different backgrounds (Yadav et al. 2016). The lack of content knowledge makes it harder for teachers to notice and understand student thinking (Hubbard and D'Silva 2018). One of the cognitive aspects supporting collaborative work is shared understanding that provides group members with having a common understanding and knowledge. Shared understanding improves individual and group understanding, making group members agree on the concepts and problems they work on (Agredo-Delgado et al. 2020). It is worth noting that employing collaborative work supported by shared understanding in CS teacher preparation programs helps overcome the difficulties stem from lack of knowledge.

This study's participants are expected to experience this challenge at a minimum since they have been trained to have sufficient content knowledge. Curricular needs consist of teachers' demand for resources to deliver the content and assess students' learning (Sadik, Ottenbreit-Leftwich, and Brush 2020). Planning CS lessons and ensuring students' engagement with different needs are considered pedagogical challenges by CS teachers (Sadik, Ottenbreit-Leftwich, and Brush 2020; Yadav et al. 2016). Sadik, Ottenbreit-Leftwich, and Brush (2020) proposed that CS teachers' primary need is to learn and use student-centred strategies, which are considered the most effective way to help students acquire digital competencies (Voogt 2008). Stimulating students' emotions and awareness in the computer science learning environments would promote their engagement and social interaction. Therefore, it might be efficient for teachers to give affective feedback, considering students' emotions and awareness, which would promote self-reflection skills about what and how they learn the concepts (Collazos et al. 2021).

CS teacher preparation's importance is addressed in much research (Gal-Ezer and Stephenson 2010; Yadav and Korb 2012). Ragonis and Hazzan (2009) proposed a tutoring model to promote preservice CS teachers' pedagogical-disciplinary skills. Kabakci Yurdakul (2011) evaluated seven preservice teachers' professional competencies in the teaching process. Erol and Kurt (2017) investigated the effect of programming on preservice CS teachers' motivation and programming achievement. On the other hand, Dağ (2019) investigated preservice teachers' views and perceptions of coding in an elective course. The related research shows a lack of research to reveal the connection between CS teachers' beliefs and teaching practices.

Kordaki (2013) investigated high-school CS teachers' beliefs, teaching practices, and the associations between teacher beliefs and teaching practices. She emphasised the importance of exploring CS teachers' beliefs and teaching practices and addressed that CS teachers' beliefs, instructional practices, and the relationship between beliefs and practices remained under-researched. Indeed, teacher beliefs and teaching practices with technology have been a topic of interest among researchers (Ertmer et al. 2012; Levin and Wadmany 2006; Ottenbreit-Leftwich et al. 2010; Palak and Walls 2009). These studies were primarily conducted with teachers who used technology effectively or had the opportunities to use technology. The aim of selecting technology-savvy teachers is to ensure that the barriers to technology are minimal and, therefore, the relationship between beliefs and practices can be comprehended more clearly (Palak and Walls 2009). However, limited research points out CS teachers' beliefs and teaching practices.

The lack of knowledge and skills related to CS has been regarded as a primary challenge for CS teachers (Sadik, Ottenbreit-Leftwich, and Brush 2020; Yadav et al. 2016) since few countries require teacher preparation institutions that allow for teachers to be certificated as CS teachers (Gal-Ezer and Stephenson 2010). Most CS teachers have different undergraduate degrees. Therefore, exploring preservice CS teachers' beliefs and teaching practices would minimise the challenges related to knowledge and skills. Even if preservice CS teachers have more technological knowledge than other field teachers, it has been seen that they still need to learn how to integrate technology for meaningful learning (Dağ 2019). This study presents preservice CS teachers' beliefs and teaching practices to provide a detailed insight into CS teacher education in Turkey. The research questions that guided data collection and analysis are identified as follows:

(1) What are participants' espoused beliefs and motivational orientations to teach CS?
(2) How do participants teach in their natural setting of the CS classroom?
(3) Is there any association between preservice teachers' beliefs and teaching practices?

## Method

This study aimed to explore preservice CS teachers' beliefs and practices within a naturalistic setting of a CS classroom and to reveal the relationship between their beliefs and practices. Case studies make it easier to investigate individual experiences (Merriam 1998) and events over which researchers have little control (Yin 2009). Multiple case study research design conducted in two phases (Stake 2006) was considered the most appropriate approach since the study aims to understand each participant within the actual context of schools and explore the differences and similarities among participants. The first phase consisted of analysing each participant as a case, and the second focused on comparing all cases to identify which beliefs lead to different teaching practices (Stake 2006). Comparisons allow researchers to "look in-depth at the significant similarities and differences between cases and the factors that explain those differences". (Patton 2015, 418). In other words, the participants were discussed both separately and holistically (Levin and Wadmany 2006).

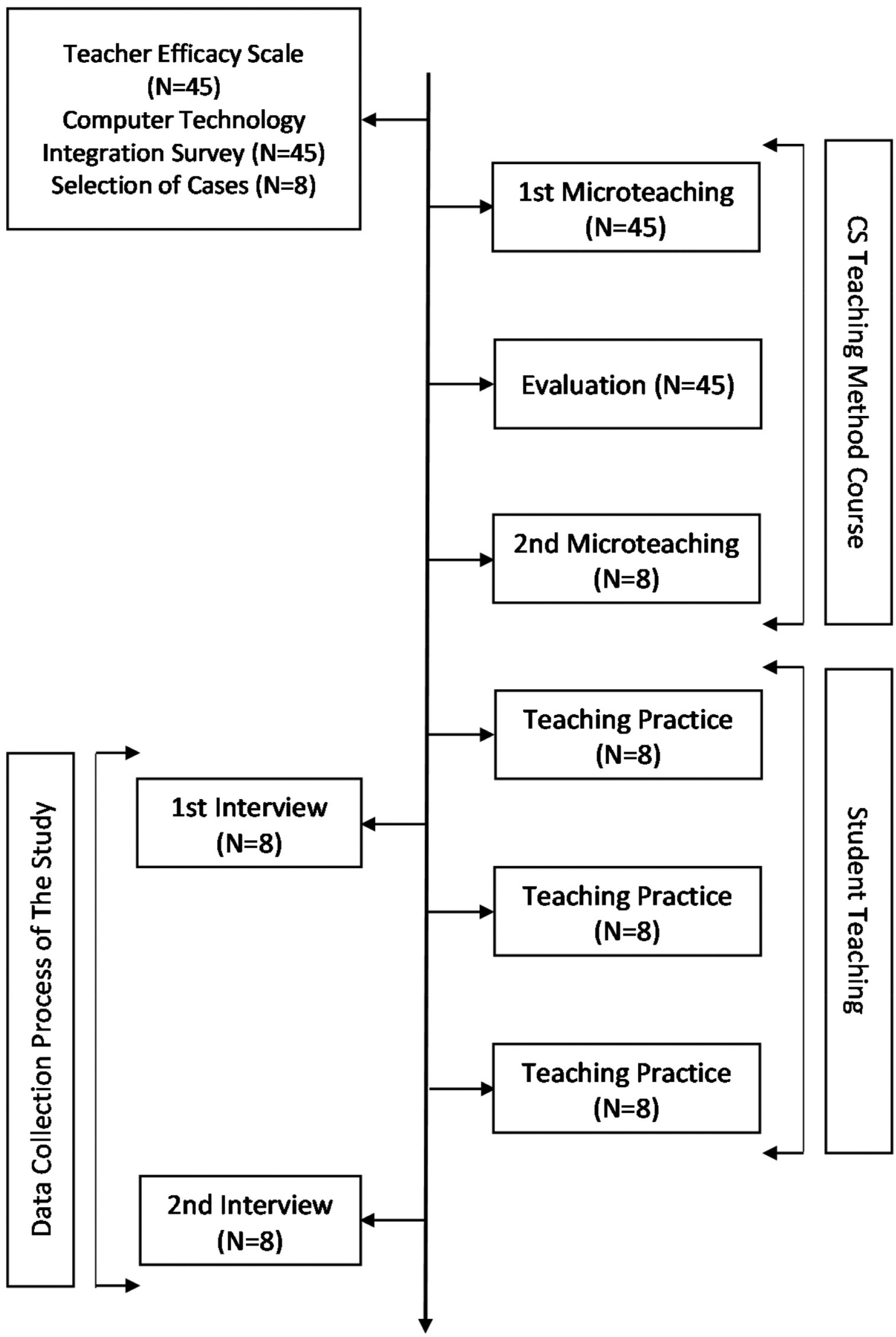


Figure 2. Data collection process.

### *The research context and selection of cases*

The study used maximum variation sampling (Patton 2015) to select cases with maximal differences based on their self-reported teacher efficacy and technology integration self-efficacy beliefs. This selection makes it possible to document as many diversities as possible and identify common patterns (Patton 2015). Figure 2 demonstrates the data collection process and the selection of cases.

Although this study deals with the data related to the participants' teaching practice (two practices for each participant), the cases were selected within the CS teaching method course that preservice teachers completed before their teaching try-outs. One of the authors was the instructor of the CS teaching method course. At the beginning of the method course, "Computer Technology Integration Scale (CTIS)" (Wang, Ertmer, and Newby 2004) and "Teacher Efficacy Scale (TES)" (Tschannen-Moran and Hoy 2001) were administered to pre-service teachers enrolled in the course (n = 45). Preservice teachers' scores that they obtained from the CTIS were listed from the highest to lowest, and preservice teachers were categorised into three groups (high, medium, and low). Firstly, we determined the preservice teachers with higher scores from the CTIS than their peers and sorted these preservice teachers' TES scores from the highest to the lowest. We selected four preservice teachers whose TES scores were higher than others in the CTIS-high group. Then, we conducted the same recruitment process for the CTIS-low group and determined four preservice teachers with lower CTIS and TES scores than their peers. The selected preservice teachers were informed about the purpose of the study and asked to participate. Thus, eight preservice teachers with different teacher efficacy and technology integration self-efficacy beliefs were selected purposefully to ensure data diversity. Forty-five preservice teachers were asked to plan and conduct a microteaching lesson independently of the study, and these lessons were videotaped. Afterwards, the instructor (expert assessor) and preservice teachers (peer assessors) assessed the lessons together. Teachers then amended their lesson plans accordingly and gave the lesson again, these too were videotaped for evaluation by the instructor and peers.

At the beginning of their student teaching, the participants planned and conducted mini-lessons and videotaped their teaching practices. After giving their first lesson, the participants were interviewed to identify their beliefs and reflections on their prior teaching practices. Then they conducted two more videotaped lessons in their assigned schools, and the second interview was conducted after their final practicum session.

Four female and four male preservice teachers participated in the study. We gave them a pseudonym. Table 1 demonstrates participants' gender and self-reported levels of teacher efficacy and technology integration self-efficacy.

**Table 1.** Participants' gender and self-reported efficacy levels.

| Participant | Gender | Self-reported teacher efficacy | Self-reported self-efficacy for technology integration |
|---|---|---|---|
| Ali | Male | High | High |
| Aslı | Female | Low | Low |
| Şule | Female | Low | Low |
| Aziz | Male | High | High |
| Barış | Male | High | High |
| Fatih | Male | High | High |
| Evrim | Female | Low | Low |
| Selcen | Female | Low | Low |

### *Data collection tools*

We collected data via in-depth interviews and observations to identify the participants' beliefs and motivational orientations, how preservice teachers taught the subject CS, and why they preferred the way they teach. Two teaching practices in actual classrooms were included in the data analysis. Interviews were conducted before and after these teaching practices. Interviews served as the primary data source to reveal what they believe about CS education and why participants do what they do. We used a semi-structured interview protocol that consists of the questions related to preservice teachers' (a) beliefs about technology and teaching CS (Hsu 2016), (b) efficacy beliefs for technology and technology integration (Bender et al. 2016), (d) motivational orientations for the subject CS and teaching the subject CS (Bender et al. 2016), and (e) descriptions of their teaching practices. The interviews lasted between 28 to 40 minutes and were audiotaped, taking participants' permission.

Participants conducted five videotaped mini-lessons, of which two were within the context of the method course, and three were in student teaching. We sought to reveal how participants' espoused beliefs shaped their teaching practices, and we thought we needed to minimise the factors such as stress because of videotaping or being observed. It is known that being videotaped, being evaluated by the instructor, and the first teaching practice in the classroom make preservice teachers experience discomfort (Hervas, Medina, and Sandín 2020). The microteaching sessions helped participants feel comfortable while teaching while being recorded on video, and they provided scaffolding for preservice teachers to plan and conduct a lesson. The first teaching practice session was the first-time participants had taught students in classrooms; in other words, it was the first time they experienced the "reality shock" that may limit their abilities to enact their teaching as they intended (Ottenbreit-Leftwich et al. 2018). Therefore, microteaching in preparation for the first teaching practices are supposed to minimise the barriers that hinder preservice teachers from teaching as they planned. We included their last two teaching practices in the data analysis. Teaching practices were videotaped, and the researchers did not participate in these sessions so as not to intervene in the natural setting of the classroom.

Participants also wrote a short reflection to identify their students' characteristics and learning styles, state the outcomes of their instruction, and explain their selection of software or material and how they planned to use technology. Using multiple sources of data (data triangulation) provided substantial opportunities for detailed and comprehensive descriptions of why preservice CS teachers do what they do within the actual context of a school.

### *Data analysis*

Interviews and video-recordings were transcribed, and we first read all the transcripts without analysing them. Reading helped us to gain an opinion about all participants. We used open-coding to identify a codebook consistent with the literature related to teacher beliefs, motivational orientations, and teaching practice (Bender et al. 2016; Hsu 2016; Kordaki 2013) and conducted open-coding and created codebooks separately to ensure reliability and internal validity. The Kappa coefficient was found to

**Table 2.** Codebook used to analyse data.

| Theme | Category | Definition | Example |
|---|---|---|---|
| Teacher beliefs and motivational orientations | Positive value beliefs about technology | Beliefs about the positive effect of technology on instruction | *Technology makes instruction more permanent and effective.* |
| | Moderately-positive beliefs about technology | Beliefs about the moderately-positive effect of the technology on instruction | *The pros and cons of technology in instruction are in balance.* |
| | High teacher efficacy | High confidence about influencing students' learning | *I think my students learn what I teach.* |
| | Low teacher efficacy | Low confidence about influencing students' learning | *I did not allow students' questions not to disturb regular classroom activities.* |
| | High self-efficacy | High trust in their abilities related to technology | *I can handle all technologies that can be used in instruction.* |
| | Low self-efficacy | High trust in their abilities related to technology | *I worry about failing to solve technical problems.* |
| | High efficacy beliefs for technology integration | High trust in their abilities regarding instructional technology use | *I can encourage my students to use technology effectively.* |
| | Low efficacy beliefs for technology integration | Low trust in their abilities regarding instructional technology use | *I can use technology if I see a modelled use (video of a teacher, sample lesson plan, etc.).* |
| | High level of enthusiasm | High level of interest in technical innovations in CS | *I follow innovations and have a willingness to stay up to date.* |
| | Low level of enthusiasm | High level of interest in technical innovations in CS | *I do not follow innovations.* |
| Teaching practices | Technology role | Drill-and-practice | *Preservice teachers used the technology without students' use* |
| | | Direct Instruction | *Preservice teachers allowed students to use the technology* |
| | Exploiting students' prior knowledge | Yes | *Preservice teachers asked students what they knew about the topic* |
| | | No | *Preservice teachers did not ask students what they knew about the topic* |
| | Student involvement | Few | *Few students participated in the lesson.* |
| | | Most | *Most students participated in the lesson.* |
| | Handling students' mistakes | Providing the correct answer | *The preservice teacher gave the right answer.* |
| | | Encouraging students to be self-corrected | *The preservice teacher made students realise the correct answer.* |

be .85 for the inter-rater reliability. Then, the codebooks we made were compared and modified (Table 2), and we used the codebook's final form and grouped our open codes into the codebook categories. We came together to compare and discuss our codes and their categories. Table 2 shows the categories and the definitions of these categories in the codebook.

We then watched the videotapes of teaching practicums and took field notes. Then the transcriptions of video-recordings were analysed through the same coding process as the analysis of interview transcripts. The categories to examine teaching practices were derived from Kordaki's (2013) study in which she investigated high school CS teachers' beliefs and teaching practices.

The data analysis was undertaken in two phases; (a) analysing individual cases and (b) comparing multiple cases based on the similarities and differences in their beliefs and practices. We first analysed each participant's data from the interviews, observations, and reflections and created a narrative for each participant describing how they taught the lesson and what they believed. Then, we made a table that demonstrates all participants' beliefs and teaching practices to make it easier to compare participants.

### *Trustworthiness*

We used triangulation of the source (collecting data from participants selected via maximum variation sampling) and the methods (collecting data via interview, observation, and reflection) to produce suitable evidence of the trustworthiness of the researchers' analysis (Merriam 1998; Yin 2009). The second author is the instructor of the method course. It is essential to make participants feel confident and trust the researchers. Supporting the interpretation with data (i.e. examples of text) makes the interpretations valid (Auerbach and Silverstein 2003). Therefore, we gave interview quotes to support participants' espoused beliefs.

Additionally, detailed information and narratives about the participants ensure the transferability of the results of this study to other various contexts of participants (Lincoln and Guba 1985). The last step to ensure trustworthiness was peer review. The researchers planned, collected data, analysed it independently, and discussed their interpretations until they reached a consensus.

## Results

The first part of this section introduces each case individually, and the second part comprises comparisons and contrasts among participants.

### *Case 1: Ali*

Ali thought that technology enables the use of different sources and representations and access to various information immediately. He was appointed to be responsible for the computer laboratory by his teacher when he was in high school. Therefore, he reported a high level of technology self-efficacy. He stated that he was comfortable with all technologies he used in his teaching practices. His high level of self-efficacy also prompted his efficacy beliefs for technology integration. He expressed that he trusted his ability to guide his students to use technology efficiently and effectively in his instruction.

To Ali, it is essential to adjust the instruction to the proper level for individual students. For example, he said, "When I first asked my students about the algorithm, I realized they were confused. So, I decided to relate the concept of the algorithm to their daily lives. I asked them the steps to make tea". He explained that he allowed his students to work individually with computers and controlled whether they comprehended what he taught. He reported being interested in contemporary technological innovations.

He started his first teaching practice by exploiting students' prior knowledge. For example, he asked students whether they had prepared a PowerPoint presentation before teaching them how to insert items in a presentation. Ali first taught students the content using NetSupport School, allowing him to share his screen with students' computers. Then students had the opportunity to work with computers individually. He walked around the class and controlled what students did. His second teaching practice was related to algorithms and flow charts. He preferred to use the demonstration method by using a PowerPoint presentation. Students rarely participated in the lesson; they were passive receptors. According to Ali, the algorithm was a complicated subject for students; therefore, direct instruction was the most appropriate strategy to teach them about algorithms.

## *Case 2: Aslı*

Aslı is worried about making mistakes, so she felt anxiety in the method course. She reported difficulties managing the classroom and answering students' questions in her teaching practices. Her beliefs about technology were addressed using technology to support concepts the teacher taught, although she expressed that technology makes information more accessible and makes the instruction more enjoyable. She also added that she avoids using technology when teaching difficult concepts.

Aslı described that she feels more comfortable teaching with technology when she finds and follows template lesson plans. This may be because she did not trust her knowledge of technology. She addressed the importance of being adaptable to technical innovations, but she reported that she did not keep updated on the latest innovations. She espoused the belief that technology should be used for briefing the lesson and evaluating students with tests. For example, she said: "I first lectured my lesson, and then I used videos/activities to support what I taught". She also insisted that students could use technology after the teacher demonstrated it.

She taught "Browsers and search engines" in her first teaching practice and "e-mails" in the second teaching practice. Aslı asked questions primarily to associate CS concepts with students' daily lives. Students gained information through a PowerPoint presentation. They watched a video related to the presentation at the end of the first teaching practice. In the second practice, Aslı used a digital activity to show students how to set up an email account properly. The activity was undertaken using the smartboard. The teacher asked students about their proposed email accounts, and she wrote on the smartboard. She reported that her cooperating teacher did not allow students to use computers. However, neither did she allow her students to use the smartboard.

## *Case 3: Şule*

Şule thought that technology could make the instruction more efficient and effective, but she felt anxious about technical problems. She referred to the fear of facing technical issues many times in the interviews. She did not follow technological developments. She trusted in her abilities about the school curriculum, but the social norms that assume the CS teachers can handle all the technical difficulties constrained her technology use. She described that using the smartboard ensures that all students stay on task. For example, she said, "If I let all students use computers, there were too many students that I must assist. I used the smart board, so I had the chance to determine the number of students that I need to assist".

It is seen that she has conflicting beliefs about whether to allow students to use computers. She stated that students should have the opportunity to use computers individually. Conversely, she also said that students should not be given the responsibility of using computers on their own because their inappropriate use of computers may elicit technical problems. Şule reported a high level of trust in her abilities about promoting students' learning. She emphasised the importance of adjusting instruction to students' levels and relating the CS concepts to their daily lives.

Şule began the teaching practices by asking questions to exploit students' previous knowledge. She used PowerPoint materials to deliver the content and videos to summarise the content after she taught. Students participated in the lessons to answer the posed questions. Her cooperating teacher did not allow students to use computers, so Şule taught the classes via the smartboard. Students used the smartboard to answer the questions in an online assessment test.

## *Case 4: Aziz*

Aziz thought that his teaching promoted students' learning and participation. He expressed that he used different strategies to engage the attention of students with different levels of interest. For example, he stated, "My students will learn because I aim to teach in a way that they will use CS throughout their lives". He also explained that he controlled each student when working with computers. He stated that CS concepts could be learned if they are related to daily life experiences.

He trusted his abilities with technology, and he expressed that he was comfortable with the ones he used in his lessons. He reported that he encouraged his students not to be afraid of using computers. His value beliefs about technology indicated that it can be used to give immediate feedback about students' performance and makes the instruction more efficient. He is also really interested in innovations and willing to expand his skills. He said that he had a website.

Aziz taught about making PowerPoint presentations in the first teaching practice and computer networks in the second. His two practices were different in terms of technology roles. In the first practice, he taught students how to insert items in PowerPoint. He shared his screen with students' computers, demonstrated to them how to insert items, and then let them work on their computers to insert items. When students worked with computers, he walked around the class, reviewed what they did, and helped those who needed support. In the second practice, he performed direct teaching with student involvement. He used a cardboard activity for evaluation at the end of the lesson.

### *Case 5: Barış*

Barış believed that he could use all technologies, including those he had not met before. He valued technology as he thought it can be used to promote instruction in a more efficient, effective, enjoyable, and permanent way. He self-reported himself as keeping up to date on technological innovations and seeking ways to teach better.

He trusted in his abilities to engage attention and encourage the participation of students. He expressed that he sometimes asked students with low interest; thus, attempting for all students to be involved in the lesson. To Barış, it is necessary to encourage students to use technologies without fear. To achieve this goal, he described that the most crucial factor was confidence. He reported that he got more confident in allowing students to use technology. He declared, "At first, I was the one who used technology in the classroom, but in time my efficacy to make students use technology increased, and in my last teaching practice, I allowed my students to use technology". He specified that the instruction should consider students' different needs, and the teacher should allow the students to self-correct their mistakes.

Barış was sensitive to exploiting students' previous knowledge; he introduced the topic and asked students what they knew. His teaching efficacy made him motivate students with low interest by asking them questions that they could answer. He used Kahoot to assess students' comprehension of what he taught. Students connected to the game with their computers. He taught algorithms in the second practice. Considering that the concept of algorithms may be complicated for students, he wanted to ensure that students comprehend every step. A digital assessment tool that gave students immediate feedback on their answers was used to assess student learning.

### *Case 6: Fatih*

Fatih explained that technology encourages students not to learn memorisation via its visualisation aspect. He reported that his self-confidence in technology was relatively high. He had a great enthusiasm to follow technological changes. He noted that he had been the moderator of a website related to technology. He expressed that he trusted his ability to solve the technical problems he faced in instruction and addressed the importance of allowing students to research and work with technology.

To Fatih, the teacher is essential for instruction, but he referred that instruction should consider the students' different needs. He told about his strategies for students with confusion or low interest. He described that he showed students the importance of CS and how it is related to their daily and future lives. He stated, "I think that all students should learn CS even if they do not like it. I realise that their interest increased when I relate the CS to their daily lives and future careers". He said he always controlled what students did, gave more importance to confused students, and let the capable ones brief the lesson. He seems to be inclined to allow students to use technology, but he stated that the students should only use technology after the teacher's lecture.

His teaching began with asking engaging questions to spark students' interest in the subject and exploit students' previous knowledge. He first taught the content and then let students work with their computers for drill-and-practice. Most of the students participated in the lesson. In the second practice, students used Scratch on the smartboard to understand the algorithm better, and it seemed a unique experience for students.

### Case 7: Evrim

Evrim believed that technology has benefits such as visualisation, increasing student participation, and supporting teaching and learning. She reported that she felt comfortable with smart boards, computers, and PowerPoint but not with complex concepts such as coding. She stated that she had information about technological developments if they were mentioned in the teacher preparation courses.

She reported that she preferred teaching materials that did not include technology and explained that students were interested in these materials. Her anxiety about managing the classroom may explain the reason for this choice. Although she valued technology as an instruction tool, she also thought that students perceived computers as only useful for playing games. The concern of failing in classroom management made her not allow students to use technologies and ask questions. She stated, "I told students not to ask many questions since I thought that questions disturbed the regular classroom activities".

Evrim performed direct instruction without student involvement in her first practice. She delivered information about the keyboard using PowerPoint material that consisted of multiple demonstrations. Then, students were asked questions about the keyboard. Her teaching style differed in the second practice. She firstly asked questions about the computer networks and then transmitted the content via PowerPoint material. She used Kahoot to assess students' learning. However, she connected her phone to the smartboard, students told the answer, and she entered the answers with her phone. Students' technology use was rare.

### Case 8: Selcen

Selcen believed that technology gave immediate feedback about student performance and made the instruction more efficient with its visualisation, dragging, and animation aspects. She stated that she encouraged her peers from different disciplines to use technology. To Selcen, students were interested in technology, and the most efficient way of delivering CS content is game-based activities. She said that she tried to develop herself to be a good teacher instead of being a technology expert. She also added that she felt anxiety about learning new technologies independently.

She stated that she paid attention to adjusting her instruction to a proper level for students, not correcting their mistakes, and avoiding direct instruction. She addressed the importance of helping students to relate their existing knowledge to the new knowledge. She specified that it is essential to relate CS concepts to daily lives enjoyably.

Selcen paid attention to providing students' participation by asking them questions. Throughout her practices, she used question/answer to exploit students' prior knowledge and assess learning. She used a digital assessment tool in the second practice and let students engage with this assessment tool on the smartboard.

## *The comparison of cases*

The second phase of the data analysis focused on comparing the cases, considering the similarities and differences in participants' beliefs and teaching practices. Table 3 demonstrates the beliefs and teaching practices of participants. All participants addressed the importance of connecting CS concepts to students' daily lives and requiring active participation to ensure quality teaching CS. In a way to support their beliefs, they all used question/answer to make students engaged with lessons and mentioned how the CS concepts they taught are associated with their daily lives. Participants with a high level of efficacy in using and integrating technology also provided students' participation by letting them work with their computers or on the smartboard.

It is seen that male preservice teachers reported a high level of efficacy in technology and technology integration. The high level of efficacy related to using and integrating technology encouraged them to let students work with computers individually. Participants who reported a high level of efficacy in using and integrating technology also described a high enthusiasm level. However, Ali and Aziz avoided allowing students to work with computers in their second practices. Ali explained that the algorithm is theoretical, complex, and challenging to teach with students' working with technology. Aziz reported that classroom management was difficult for him when he let students work individually, and then he decided to use the smartboard to focus students' attention on him.

Participants' teacher efficacy seemed to affect how they handled students' mistakes and whether they revealed students' previous knowledge. Aslı and Evrim, the ones with low teacher efficacy, provided students with the correct answer and did not endeavour to reveal students' prior knowledge. Other participants paid attention not to give the correct answers to students. Evrim is also the only participant who made few students involved in the lesson in her teaching practices. Lastly, most participants (Aslı, Şule, Aziz, Fatih, and Evrim) mentioned classroom management. For example, Evrim said that she did not allow students to ask questions for fear of losing control. Aziz, Aslı, and Şule stated that delivering content via smartboard is an effective way of managing the classroom. Fatih reported that classroom management is crucial; therefore, the teacher needs to control the classroom. He did not allow students to use their computers in his second teaching practice because he said students did not stay on task when working with them.

**Table 3.** Participants' beliefs and teaching practices.

| | Beliefs | | Motivational Orientations | | | | Teaching Practice | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Efficacy beliefs | | | | | | | |
| Participants | Beliefs about teaching CS | Value beliefs | Teacher efficacy | Technology self-efficacy | Self-efficacy for technology integration | Enthusiasm | Technology role | Students' prior knowledge | Student involvement | Handling students' mistakes |
| Ali | DL<br>AP | Positive | High | High | High | High | DP (1)<br>DI (2) | + | Most (1)<br>Few (2) | E |
| Aslı | DL<br>AP | Moderately positive | Low | Low | Low | Low | DI | | Few (1)<br>Most (2) | P |
| Şule | DL<br>AP | Positive | High | Low | Low | Low | DI | + | Most | E |
| Aziz | DL<br>AP | Positive | High | High | Moderately High | High | DP (1)<br>DI (2) | + | Most | E |
| Barış | DL<br>AP | Positive | High | High | High | High | DP | + | Most | E |
| Fatih | DL<br>AP | Positive | High | High | Moderately high | High | DP | + | Most | E |
| Evrim | DL | Positive | Low | Moderately high | Low | Low | DI | | Few | P |
| Selcen | CPK<br>DL<br>AP | Positive | High | Low | Moderately high | Low | DI | + | Most | E |

CPK: Connecting previous knowledge with new concepts, DL: Associating the CS concepts to daily life, AP: Active participation
DP: Drill-and-practice, DI: Direct Instruction
E: Encouraging students to be self-corrected, P: Providing the correct answer to students' mistake

To sum up, participants reported and espoused that efficacy related to using and integrating technology and the anxiety level of managing the classroom impacted technology's role in their teaching practices. How to handle student mistakes seemed to be related to the level of teacher efficacy. The number of students involved in lessons is seen to depend on the preservice teacher's teacher efficacy level or beliefs associated with the nature of the topic.

## Conclusion and discussion

This study examined preservice CS teachers' beliefs and teaching practices in the natural settings of CS classrooms. Eight preservice teachers were selected based on their self-reported teacher efficacy and self-efficacy beliefs for technology integration to ensure maximum variation. Participants were observed throughout two of their teaching practice sessions, and interviews were performed just before and after these. Participants expressed that connecting CS concepts to students' daily lives and requiring learners' participation was essential in teaching and learning CS. Consistently with these beliefs, they all associated the CS concepts with daily life and attempted to get students to participate in the lesson. The participant teachers in the Tew, Fowler, and Guzdial (2005) study reported that students did not value CS if they could not connect CS to their personal lives and future careers. In the present study, Fatih explained that articulating the connection between students' lives and future careers increased students' interest in learning CS.

Participants mostly used questions/answers to motivate students to engage with the lesson. However, participants with higher efficacy in using and integrating technology also allowed students to work with the available technology (e.g. computers, smartboards) to increase their motivation. Self-efficacy is reported as influential as knowledge (Pajares 1992). All participants knew about technology, but those with higher technology self-efficacy attempted to allow students to use technologies. This may be because they believe in their abilities to solve technical problems. This result underpins the statement that suggests that self-efficacy may be more crucial than skills and knowledge (Ertmer et al. 2012).

Participants emphasised that adjusting the lesson to the proper level for students is crucial, and most of them, with higher teacher efficacy beliefs, asked students what they know or think about the topic at the beginning of the lesson. Those with lower teacher efficacy did not exploit students' prior knowledge and provided the correct answer to students' mistakes. A low level of teacher efficacy may cause discomfort in eliciting desired outcomes such as student engagement and students' construction of learning (Tschannen-Moran and Hoy 2001). Therefore, participants with low teacher efficacy focused on their teaching regardless of students' participation and understanding. It is seen that PSTs collaborate with their students to promote their learning with a low level of technology use. Technology self-efficacy beliefs hindered PSTs' collaboration supported by efficient technology use with students. It is known that teachers might have difficulties determining how to evaluate and intervene in a collaborative learning environment supported by technology use (Collazos et al. 2021).

Classroom management seemed to affect participants with different levels of efficacy. A failure to manage the classroom made participants perform direct instruction and avoid using digital assessment tools and allowing the class to work with computers. PSTs' concerns regarding classroom management constrained their awareness, which is essential for teachers to realise what students are doing and decide when and how to intervene (Collazos et al. 2021). For example, Aziz reported a high level of technology efficacy, and he expressed that he could deal with technical problems quickly in his first practice. However, he avoided allowing students to use computers in his second practice. He said that students' work with computers led to disturbing behaviours and made it harder to manage the classroom. Similarly, Şule reported that delivering the content via the smartboard helped her in classroom management. Besides, Ali chose to perform direct instruction in the second practice, contrary to using drill-and-practice in his first practice. He explained that the topic of the algorithm he taught in his second practice is complex for students, and direct instruction is the most appropriate technique to teach this challenging topic.

On the other hand, the concern of managing the classroom constrained Evrim from allowing students to ask questions. Fatih and Selcen thought that using only demonstrations in PowerPoint presentations would make them the authority in the class and make it easier to manage the classroom. These results are consistent with the comments of Ragonis and Hazzan (2009), that suggested that concerns such as classroom management may disable preservice CS teachers in following up on students' learning and the impact of their teaching on the students. Besides, classroom management is one of the most significant concerns for preservice teachers who teach students in schools for the first time (Kartal and Çinar 2018; Liaw 2009; Yadav et al. 2016). Classroom management may be challenging for participants due to the perceived student culture that CS was only necessary for playing games. Similarly, Kordaki (2013) proposed that this perceived student culture constrained teachers' practices. Figure 3 demonstrates the interactions between participants' beliefs and practices.

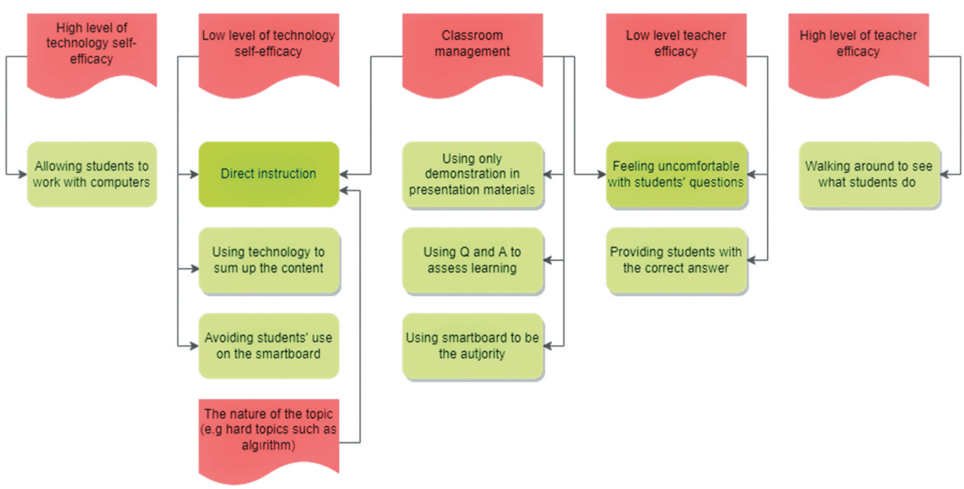


**Figure 3.** The connections between preservice CS teachers' beliefs and practices.

The influencing factors on teaching practice are related to technology self-efficacy, teacher efficacy, the concern of classroom management, and the nature of the topic. Figure 3 demonstrates the participants' beliefs and teaching practices affected by these beliefs. The red shapes refer to the preservice teachers' prominent beliefs that affect their teaching practices. On the other hand, the green figures refer to the preservice teachers actual teaching practices. As the number of beliefs affecting the teaching practice increases, the darker the colour of the mentioned teaching practice gets. For example, "direct instruction" was influenced by three beliefs: low-level technology self-efficacy, the nature of the topic, and the concern for classroom management and has the largest number of affecting beliefs, making it dark green. Low levels of technology and teacher efficacy beliefs and the concern for classroom management might hinder preservice teachers' practices to support collaborative work with students. The teaching practices related to these beliefs impede students' active collaboration with the teacher and their peers to make sense of the knowledge. The figured model might contribute to the design of teacher preparation programs, considering the "people" aspect of the design guidelines.

Participants reported that they had sufficient content knowledge to deliver the topic of the lesson, but they worried about making it comprehensible to all students. Evrim explained the reason for avoiding students' questions due to a lack of confidence in her PCK and classroom management skills. This result may imply that CS teacher education programs minimised the effect of content knowledge as a challenge that is most reported in research (Yadav et al. 2016; Sadik, Ottenbreit-Leftwich, and Brush 2020). However, teachers with low technology self-efficacy were hindered from using technology effectively and providing their students with opportunities to use it; consequently, collaborative learning was limited. It might be better to develop a shared understanding among teachers and students to determine what students learn, what they misunderstand, and how to promote learning and intervene in misunderstandings (Agredo-Delgado et al. 2020).

The main conclusions of this study are that: (i) preservice teachers who are confident with technologies tend to allow students' technology use, but issues such as classroom management and perceiving the subject as difficult hindered these participants' tendency to allow students to use technology, (ii) preservice teachers did not report lack of subject matter knowledge, but they emphasised their lack of experience of teaching and the concern about how to make the subject comprehensible to students, (iii) preservice teachers seemed to agree with the aspects of constructivist teaching such as exploiting students' prior knowledge and encouraging students to be self-corrected in the interviews. However, participants with a low level of teacher efficacy failed to perform these aspects. Professional development programs that aim to improve PSTs' skills and awareness in determining what is happening in the teaching-learning process would help them increase group interactions in their classrooms, leading to effective technology use by the teacher and students to develop a shared understanding.

The number of subjects participating in the study was limited. Therefore, generalisation of the results should be avoided. Nevertheless, it is hoped that the results will contribute practical knowledge that could guide teacher educators to help preservice teachers be aware of their beliefs and practices and self-reflect on them. However, the present study did not obtain sufficient evidence of preservice teachers' awareness of what and how their students learned, which is an essential aspect of the design guidelines (Collazos et al. 2021). Therefore, future research should investigate how preservice teachers notice students' learning by considering the students' emotions in different scenarios. The relationship between teacher beliefs and teaching practice should also be explored in different scenarios, such as online learning. Besides, the consistencies and contradictions between beliefs and practices were not unpacked. Further researchers may examine the consistencies and contradictions between preservice CS teachers' beliefs and practices. Additionally, it may be worthwhile to study the change in preservice CS teachers' beliefs and knowledge during field experience and describe best practices in the field experience to motivate CS teacher education.

## Disclosure statement

No potential conflict of interest was reported by the author(s).

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