Using the Technology Acceptance Model to Understand Intention to Use a CS-based Curriculum

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***Abstract*—In the ever-evolving field of computer science (CS) education, the significance of K-12 teachers and their backgrounds have often been overshadowed by the predominant focus on students. Teachers in K-12 often lack the necessary expertise in CS and have limited support provided by existing CS-based curricula. While research on CS education effectiveness grows, limited attention has been given to the factors influencing teachers' intention to use or adoption of CS-based curricula.**

Prior research revealed that despite professional development and positive reactions to teaching innovations, curriculum adoption cannot be guaranteed. However, existing studies have concentrated on university-level instructors who possess extensive CS knowledge and a strong passion for teaching it. In this research study, we apply the Technology Acceptance Model (TAM), which factors perceived ease of use, perceived usefulness, and attitude into the intention to use technology, as a framework for understanding and predicting the intention to use a CS-based curriculum among secondary mathematics graduate teacher candidates in their last quarter of student teaching.

Our findings highlight the TAM as a valuable tool for evaluating teachers' attitude toward and intention to use CS-based curricula, enabling informed decision-making for future curriculum developers. Teacher candidates who expressed a negative intention to use expressed concerns regarding Teacher Knowledge, Student Understanding, and Student Resources, while those who intended to use emphasized their appreciation for Lesson Plan Content and Lesson Plan Quality. It was interesting that prominent themes in perceived ease of use, which were Lesson Plan Content and Lesson Plan Quality, differed from the most frequent themes that emerged in perceived usefulness, namely Student Understanding, Student Engagement, and Pedagogical Alternative. This contrast highlights the importance of considering multiple factors and perspectives when designing and assessing CS-based curricula, which can help curriculum developers create more inclusive CS-based curricula that address and support the diverse backgrounds of K-12 teachers.

***Index Terms*—Computer science education, Technology Acceptance Model, curriculum, K-12 teachers**

I. Introduction

Traditionally, the focus of curriculum development has been on the students and not on the teachers and their backgrounds. However, in K-12, many teachers teaching curricula that involve computer science (CS) understanding do not have a background or experience in CS [1]. We believe that current K-12 CS-based curricula are not written in a way that supports a broad range of teachers with different levels of knowledge and comfort for teaching CS, and the lack of attention to teacher CS backgrounds in CS-based curricula can impact teachers' adoption and use of curricula. While there exists a growing body of literature on the efficacy of CS education, there is not much research investigating the factors that influence teachers' adoption and use of CS-based curricula.

Research shows that professional development and positive responses to new innovations for teaching CS or Information and Communications Technology (ICT) do not always lead to the adoption of curriculum innovations or educational technologies [2]–[4]. One of the studies shows that the adoption of new introductory CS curricula by faculty at the undergraduate level depends on four main themes: 1) the curriculum, 2) the students, 3) themselves, 4) and organizational or social factors, and faculty's prior background and experiences either motivated or prevented the adoption of different curricula and technologies [2]. However, most research into the adoption and consideration of CS curriculum is at the university level with instructors who are knowledgeable about CS and hopefully passionate about teaching it.

The Technology Acceptance Model (TAM) explains how a person's perceived ease of use, perceived usefulness, and attitude are major factors impacting their acceptance or not of different technologies. TAM has become an increasingly popular model for predicting technology acceptance in teaching and learning, especially related to e-learning. Despite TAM's growing use in educational contexts, the model has been primarily used to predict technology acceptance among students, rather than teachers, and it has not been used to predict acceptance of CS-based curricula by K-12 teachers.

In this research paper, the term "CS-based curriculum" refers to any educational curriculum that incorporates CS/computational concepts, such as problem-solving and critical thinking, to enhance students' comprehension of algorithms, data representation, computational modeling, and the utilization of computational tools and technologies to address problems in diverse fields. Such a curriculum commonly integrates CS principles with other subject areas like mathematics, science, engineering, and social sciences.

Due to the amount of technology used in most CS-based curricula, we believe the TAM provides a good starting place for determining the factors that play a role in teachers' acceptance of CS-based curricula, and we hypothesize:

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The TAM can be used as a framework to understand teachers' intention to use a CS-based curriculum.

Specifically, this research study investigates how secondary mathematics graduate teacher candidates perceive a computation-based curriculum and attempts to identify factors that may influence their acceptance and use of computation in a curriculum.

II. BACKGROUND

A. CS Curriculum Adoption

In K-12 education, pedagogical content knowledge (PCK) is a teachers' knowledge of how to teach a specific content area. Past research showed that PCK and beliefs were main contributors to teachers' adoption of a curriculum [5], but this did not include K-12 CS curricula. At the time of this research, we are unaware of any research on what impacts K-12 teachers' adoption of CS curricula. Therefore, we leveraged studies conducted in higher education to inform our research.

Past research indicated that the adoption of new curricula or educational technologies did not always follow professional development or positive reactions to new innovations for teaching CS [2]–[4]. Ni [2] identified four key factors that influenced faculty members' decisions to adopt a new introductory CS curriculum at the undergraduate level: the curriculum itself, the students, the teachers, and organizational or social issues. The most influential factors in deciding whether to adopt a new introductory CS curriculum were 1) the attitudes and beliefs of the faculty about the effectiveness of the curriculum in preparing students for future CS classes, 2) the content and context covered, 3) the learning objectives, 4) the time required to prepare for and use the material, and 5) the interests and prerequisite skills of the students. Other significant barriers to adoption included the organizational structure and resources of the curriculum, as well as external social factors, such as funding, departmental support, and textbook availability that may be beyond the control of the faculty.

Likewise, researchers in the fields of Information Systems (IS) and Information and Communications Technology (ICT) education found that a range of variables, including the technology being used, the faculty, the students, organizational constraints, the academy, the community, and competition, influenced the design and adoption of university curricula [4], [6], and Franklin [7] found that faculty acceptance of new technologies in CS curricula depended largely on their assessment of their potential benefits to industry and society. These studies were conducted at the university level with instructors who knew CS well and, ideally, were passionate about teaching it. We believe the factors influencing K-12 teachers' decisions to adopt CS curricula differ from those in higher education, such as K-12 teachers' experience with CS [1], [8]–[10].

B. Theoretical Framework

Since most K-12 CS curricula are online and make use of many digital technologies and software, we believe that frameworks for creating and evaluating adoptable software and technologies can offer insight into evaluating how adoptable CS curricula are for K-12 teachers. The Technology Acceptance Model (TAM) has been widely used in research to predict a person's adoption of technology [11]–[17] and the adoption of technology in education [18]–[23]. Therefore, we chose to use the TAM as an initial framework for exploring what impacts K-12 teachers' adoption of curricula that teaches CS concepts.

1) The Technology Acceptance Model: Fred Davis developed the TAM in 1989 [24], [25] as a way to explain and predict the acceptance and use of technology by individuals (see Figure 1). The original TAM determined the impact of four variables upon the actual adoption of the technology. The variables in the original TAM were: perceived ease of use (E), perceived usefulness (U), attitude toward use (A), and behavioral intention to use (BI).

It was based on the idea that two main factors influence the decision to use technology: perceived usefulness (U) and perceived ease of use (E). *Perceived usefulness* refers to the extent to which an individual believes that using a particular technology will help them perform their tasks more efficiently or effectively. *Perceived ease of use* refers to the extent to which an individual believes that using a particular technology is easy to use and understand. Additionally, there can be external variables, such as confidence, years of experience, etc., that can impact E and U.

E impacts U because easy-to-use technology is perceived as more useful than hard-to-use technology in work settings, and E and U impact one's attitude toward technology (A) that directly impacts BI, referring to people's predisposition to behaviors of using technology [25]. Even though there have been many version of the TAM [26], [27], we utilized the original version of the TAM and focused on its main variables, which included E, U, A, and BI.

Meta-analytical reviews established that E and U were the primary factors that determined teachers' intention to adopt technology [28], [29]. Particularly, U had a stronger effect than E on teachers' intention to implement technology [28], while attitude towards technology (A) acted as a mediator between BI and E/U in this context [29]. We incorporated experience (EX) as an external variable impacting E, U, and A on BI due to many resources highlighting K-12 teachers' knowledge and skills as being one key challenge, in addition to curricula, with teaching K-12 CS [1], [8]–[10], [30]. In this study, we did not explore the relationship between BI and actual use.

Despite the widespread use of the TAM in research on general technology adoption [11]–[17] and in education [18]–

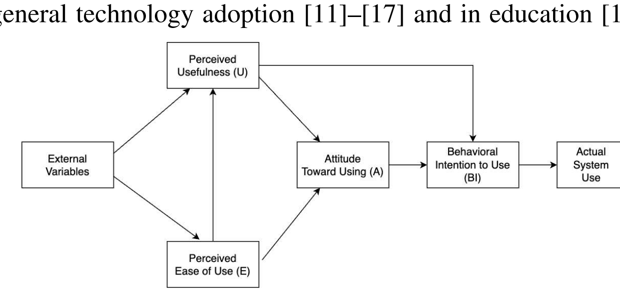

Fig. 1. The Original Technology Acceptance Model [24]

[23], we are unaware of its use to understand K-12 teachers' acceptance or adoption of CS curricula. Therefore, in the subsequent subsection, we describe examples of how the TAM has been used with students, teachers, and pre-service teachers in K-12 education outside of CS.

2) The TAM Applied to K-12 Education: Ghani et al. [18] investigated the acceptance and usage of mobile digital game-based learning among students. They employed a questionnaire-based approach to collect data on participants' perceptions of the usefulness and ease of use of the approach. Their work contributed to the understanding of the factors that influenced the adoption and utilization of mobile digital game-based learning for educational purposes.

Ibili et al. [19] explored the use of the Technology Acceptance Model (TAM) to comprehend how primary school math teachers perceived an augmented reality (AR) tutoring system. They discovered that Perceived Ease of Use (E) directly impacted Perceived Usefulness (U), but it did not directly affect Attitude (A). They also found that U had a direct effect on A, and A had a significant impact on the teachers' intentions to continuously use the system (BI).

The aim of Tang et al's [20] study was to explore K-12 teachers' attitudes toward and intention to adopt Open Educational Resources (OERs). Teachers in K-12 settings often relied on textbooks for differentiated instruction, and the study found that the perceived ease of use was a key factor in determining OERs' usefulness (U), overall attitude (A), and likelihood of use. The study revealed that half of the participants identified the difficulty of finding appropriate resources as the primary barrier to using OERs, and inefficient navigation of OER repositories was a recurring challenge. The perceived usefulness (U) of OERs was found to be a significant predictor of teachers' attitudes (A) and intentions to use them (BI), and the study noted that teachers' perceptions of ease of use (E) and usefulness (U) both had a significant impact on their overall attitude (A) toward OERs.

Teo and his colleagues conducted two studies on attitudes towards computer technology among pre-service teachers, using the Technology Acceptance Model (TAM). The first study used attitude as a dependent variable, and they found that perceived usefulness (U) and ease of use (E) had a direct significant effect on pre-service teachers' computer attitudes (CA) [31]. This was further corroborated in their second study [22], where they found that perceived usefulness (U) and ease of use (E) strongly influenced CA and intentions to use (BI), but there did not exist any significant relationship between A and BI.

Teeroovengadum et al. [21] conducted a study to explore the factors that influence the adoption of information and communication technology (ICT) in education. The study employed an extended Technology Acceptance Model (TAM) and analyzed data collected from a survey of 245 secondary school educators in Mauritius using structural equation modeling. The results revealed that perceived usefulness (U), perceived ease of use (E), and subjective norm significantly predicted ICT adoption in education. The findings indicated that educators who perceived ICT as useful and easy to use were more likely to adopt it in their teaching practices.

Joo et al. [23] investigated the factors influencing pre-service teachers' intention to use technology in their teaching practices. They utilized the Technology Acceptance Model (TAM), Technological Pedagogical Content Knowledge (TPACK), and teacher self-efficacy as theoretical frameworks and collected survey data from 186 pre-service teachers. As with many other studies, the study identified perceived usefulness (U) and perceived ease of use (E) as significant predictors of pre-service teachers' intention to use technology (BI). However, their findings revealed that TPACK and teacher self-efficacy were significant predictors of pre-service teachers' intention to use technology (BI). To address this issue, the authors recommended incorporating training on the TPACK framework and enhancing pre-service teachers' self-efficacy to increase the adoption of technology in their teaching practices.

III. Research Method

In this exploratory study, we were interested in understanding what impacts teachers' intention to adopt CS-based curricula using the TAM as an initial framework. In the following sections, we outline our research questions and provide details regarding the selected CS-based curriculum, the participants involved, and the distributed survey.

A. Research Questions

To explore what impacts teachers' intention to use CS-based curricula using the TAM, we developed the following set of research questions, and we included Experience (EX) as an external variable to understand its role in the teacher candidates' perceived ease of use (E), perceived usefulness (U), and attitude (A) toward the curriculum. Specifically, we were interested in determining if the TAM is a useful framework for understanding teachers' intention to use a CS-based curriculum.

1) What are teachers' perceived ease of use, perceived usefulness, attitude towards use, and intention to use a CS-based curriculum?
2) What are the significant relationships among the constructs in the TAM that can help us understand teachers' intention to use a CS-based curriculum?
3) How do teachers' experience (EX) impact their perceived ease of use (E), perceived usefulness (U), attitude (A) and overall intention to use a CS-based curriculum?

For RQ2, we assumed we would see the same relationships between constructs in the original TAM (refer to Fig. 1) when applying it to K-12 teachers' intention to use a CS-based curriculum. Our external variables were experience in teaching and CS, and we did not evaluate the participants' actual system use, as in the original model.

B. Bootstrap: Algebra

Since computational thinking is a part of some standards in secondary mathematics education, such as in the Oregon mathematics standards [32] and Common Core [33], we selected a well-known CS-based curriculum that teaches middle and high school mathematics with computer science called Bootstrap: Algebra [34]. Developed at Brown University, Bootstrap is a pedagogical module that covers algebraic and geometric concepts combining mathematical and computing education to provide all students in grades 7 through 12 access to and proficiency in both subjects. Bootstrap: Algebra uses computer programming to teach mathematical concepts.

A past study on Bootstrap Algebra claimed that "Committed Teachers with Varying Educational Backgrounds and in Different School Settings Can Successfully Teach Bootstrap" [34], boasting of teacher inclusivity. However, this claim was based only on the analysis of student performance. To our knowledge, no study or research has been conducted to understand teachers' perspectives and their understanding and adoption of the curriculum.

We used the *"The Numbers Inside Video Games"* lesson module in this study [35]. The purpose of the Bootstrap module is to introduce the concepts of constants, variables and coordinates in Algebra through the use of a video game called NinjaCat. The lesson requires the teachers to use a Pyret interface (also offered in a WeScheme interface) to launch the game and play it in class while students observe and consider the concepts being utilized. The goal of the module is for students to gain an understanding of constants, variables, and coordinates as they are applied within the context of the game.

C. Participants

With Institutional Review Board (IRB) approval, we recruited secondary mathematics graduate teacher candidates enrolled in Mathematics Pedagogy and Technology II, SED 576, which was a graduate-level mathematics secondary education teaching methods class at Oregon State University. In SED 576, the teacher candidates were doing their student teaching and developing their mathematical technological pedagogical content knowledge (TPACK) [36] [37]. Most students in the class were either prior or existing teachers currently getting their Masters degree.

All participants were informed about the study's objectives and their right to decline participation at any stage prior to being given the questionnaire. Eight students reviewed the lesson plan and filled out the questionnaire. One student denied consent to participate, and another student who agreed to participate filled out an incomplete form. After both sets of data were removed from the final survey results, we were left with only six teacher candidate responses to analyze.

D. Data Collection

The teacher candidates reviewed the Bootstrap: Algebra lesson and filled out the survey as a part of their final coursework in the class. They answered questions about their background and 31 multiple-choice and open-ended questions related to Perceived Ease of Use (11 items - see Table II), Perceived Usefulness (9 items - see Table III), Attitude (6 items - see Table IV), and Behavioral Intention to Use (5 items - see Table V). The multiple-choice responses ranged from 1 (strongly disagree) to 4 (strongly agree) and were based on a recent research study using the TAM to students' level of acceptance towards the use of a mobile digital game for learning Arabic language in higher education [18]. However, we adapted these questions to relate to the Bootstrap: Algebra lesson plan and teachers' acceptance of a curriculum.

A professor specializing in Cognitive and Applied Psychology and Human-Computer Interaction (HCI) reviewed the initial survey questions and provided valuable feedback. The professor recommended a revision of a few quantitative questions and the inclusion of open-ended questions to gain deeper insights into the participants' perspectives. Based on this feedback, we revised the survey questions and incorporated open-ended questions into each category. However, we did not do any sandboxing or rigorous testing of the validity of the updated survey questions, but we compare findings from the multiple-choice questions and the open-ended questions to support our understanding of how well the multiple-choice survey questions measure the TAM constructs.

IV. Results and Discussion

To answer our research questions, we first evaluated the teacher candidate responses to each multiple-choice question. Even though no teacher candidate strongly disagreed with any multiple-choice question in the survey, the majority of teacher candidates never strongly agreed with any question either. Due to the low number of participants, we were unable to run rigorous statistical tests or validate our survey questions for the different constructs. Therefore, we analyzed the quantitative data using descriptive statistics. We analyzed the qualitative data using thematic analysis [38], where we first familiarized ourselves with the data, coded the data independently, discussed similarities and differences, grouped codes by similarity, and looked for overarching themes for different sets of codes (see Table I for the 11 emerging themes with definitions and examples of each).

A. RQ1: What are teachers' perceived ease of use, perceived usefulness, attitude towards use, and intention to use a CS-based curriculum?

For each TAM construct, we discuss the responses to the multiple-choice survey questions and the emerging themes from the open-ended questions.

1) Perceived Ease of Use: In the eight multiple-choice questions, the teacher candidates mostly agreed that the Bootstrap: Algebra lesson plan was easy to use (see Table II). Everyone agreed or strongly agreed that the instructions were easy to understand, they could easily work through the lesson plan, they could start and navigate the video game, and the instructions would be easy to repeat in class. However, many teacher candidates did not feel confident about using the video game in teaching or that they could answer student questions after using the lesson plan, and it was the same teacher candidates who did not feel confident with either. Some teacher candidates did not think they could integrate the lesson into their teaching or that they were given enough resources to carry out the lesson.

From the three open-ended questions (see bottom of Table II), it was not surprising that the *Lesson Plan Contents* and

TABLE II
PARTICIPANTS' PERCEIVED EASE OF USE

Perceived Ease of Use	Strongly Agree	Agree	Disagree
Q1: I believe that the given resources were enough to help me carry out the lesson.	1	4	1
Q2: I believe that the instructions given are easy to understand.	2	4	
Q3: I found it easy to understand and work through the lesson plan.	1	5	
Q4: I would be able to easily repeat the instructions in class successfully.		6	
Q5: I feel confident I could answer any questions that a student might have about the lesson.	2		4
Q6: It would be easy to integrate the Bootstrap: Algebra lesson into my teaching practices.	1	3	2
Q7: I could easily start and navigate through the Ninja Cat video game.	2	4	
Q8: I feel confident about using the Ninja Cat video game in teaching.	1	2	3
Open-Ended Questions and Mapping to Multiple-Choice			
Q1: What impacted your confidence in using this Bootstrap: Algebra lesson plan (#5 and #8)?			
Q2: What impacted the likelihood that you would integrate the Bootstrap: Algebra lesson into your teaching (#1, 4 and 6)?			
Q3: How easy or difficult was the Bootstrap: Algebra lesson plan to use compared to other lesson plans (#2, 3 and 7)?			

Lesson Plan Quality were the two most expressed themes in the perceived ease of use open-ended questions, but it was surprising that the teacher candidates talked about the lesson plan contents within the context of students, instead of themselves. *Student Resources* and *Pedagogical Alternatives* never emerged as themes in the ease of use questions (see Fig. 2).

In the first open-ended question, we saw that *Teacher Knowledge*, in addition to *Lesson Plan Contents* and *Lesson Plan Quality*, were factors impacting their confidence to use the material, and that *Lesson Plan Relevance* to algebra emerged within confidence, which was not captured by the multiple-choice questions. For most teacher candidates, there was a relationship between their agreement on the mapped multiple-choice questions and whether they were more positive or negative in their open-ended response. There was a direct relationship between those who expressed not having the CS knowledge with disagreeing they would be confident in answering student questions or using the video game for teaching.

It is interesting that *Teacher Knowledge* was not a factor impacting the likelihood of using the lesson plan in their teaching. *Teacher Resources, Student Engagement, Student Understanding, Lesson Plan Delivery, and Class Curriculum Relevance* emerged, some of which were not captured in the multiple-choice questions. There was not a relationship between agreement on the mapped multiple-choice questions and positive or negative responses or themes in the second open-ended question.

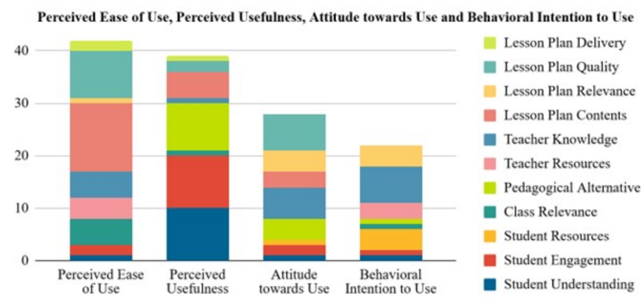

Fig. 2. Emerging Themes in TAM Constructs

TABLE I
EMERGING THEMES FROM OPEN-ENDED QUESTIONS

Theme	Definition	Examples
Student Understanding	how or what students understand as a result of the lesson plan or using computation/video games with math.	"I think students *will pick up on the ideas quickly*" [+] "*not sure that the students would understand its purpose.*" [–]
Student Engagement	how the lesson plan material or using computation/video games impacts engagement or what engagement in the material impacts	"I think that it is a *great way to engage students in math concepts with something that they enjoy*." [+]
Student Resources	district or school technology resources for students or student access to technology resources	"*If my students do not have their own technological item (laptop, ipad, etc.), then I would be less likely to use it, but if they do, I would be all for using this lesson plan.*" [+/–]
Teacher Resources	resources they invested or would invest into the lesson plan material or other Bootstrap lessons	"it *took me little time at all to learn* the processes necessary to run the lesson materials." [+] "I would again, need to *tweak the lesson before fully implementing it.*" [–]
Teacher Knowledge	their own knowledge or experiences with computation, video games, or technology in general	"I can *see the benefits when it comes from someone with more experience/knowledge*." [+] "I am *not familiar with CS practices* and that was concerning when viewing this. I am also *not familiar with video games either*." [–]
Class Relevance	the relevance to a math class(es) they teach or how they would use it in their math class(es) in general	"If I am teaching Algebra 1 and *we are talking about coordinate points and how they change in the x and y directions, I would definitely use this lesson*." [+] "I would *need to find where this lesson fits in the curriculum*." [+/–]
Lesson Plan Relevance	how the lesson plan material or using computation/video games is relevant to outcomes for math classes or math classes in general	"I *love the idea of computation in Math*." [+] "While video game development is a cool idea, *I do hesitate to have that be a learning objective*." [–]
Lesson Plan Contents	the actual contents of what is in the lesson plan material	"*Notice and Wonder's are an excellent addition*." [+] "It *lacks vocabulary* which goes against one of the learning objectives. *Some questions also would benefit from more open ended ideas*." [–]
Lesson Plan Quality	how well the lesson plan, website, or interface has been designed or how well they are or students would be able to interact with it	"It was *super organized* and *flowed very well*." [+] "it is *not very easy to use*" [–]
Lesson Plan Delivery	implementing or teaching the lesson plan	"I think it would be *easy to implement*" [+] "I believe that *I would have a hard time facilitating it.* " [–]
Pedagogical Alternative	how the lesson plan material or using computation/video games is different than current pedagogies/curricula or impacts themselves or students differently or what is different about the lesson material or using computation/video games than current pedagogies/curricula	"I think that *varying lesson types is a great way for keep students from getting bored*, and this is *another lesson strategy I can use*." [+] "Our *curriculums normally neglect on of the biggest applications of mathematics, video games*."[+/–]

In the last open-ended question, *Lesson Plan Quality* and *Lesson Plan Contents* were expressed the most, and one teacher candidate mentioned *Teacher Knowledge*. It was interesting that one person mentioned *Student Engagement*, which was not a theme we expected when comparing the ease of use to other lesson plans. For most, there was a relationship between their agreement on the mapped multiple-choice questions and whether they were more positive or negative in the open-ended question, and most teacher candidates who agreed the lesson plan was easy to understand and they could navigate the video game easily also stated how easy the lesson plan was to use and how detailed the plan was.

2) Perceived Usefulness: Teacher candidates tended to agree less strongly with their perceived usefulness compared to their perceived ease of use (see Table III). In many questions, responses were split evenly between agree and disagree or strongly agree and agree. Even though the majority of the teacher candidates disagreed that the lesson would reduce their time spent preparing to teach the same concepts, they agreed that the video game was useful and improved the lesson plan. They were split between agreeing that the lesson plan would help them teach better, students learn better, or reduce their time preparing.

From the three open-ended questions (see bottom of Table III), the prominent themes in perceived usefulness, namely *Student Understanding, Student Engagement, and Pedagogical Alternative*, differed from the most frequently expressed themes in perceived ease of use (see Fig. 2 and Table I). *Student Resources* continued not to be a factor, and neither did *Teacher Resources* and *Lesson Plan Relevance*.

In the first open-ended question, the *Teacher Resources* needed to learn something new played a role in the usefulness of the lesson plan, but the theme of the lesson being a positive *Pedagogical Alternative* also emerged as being the primary factor in how the lesson plan would impact their teaching. Three out of six mentioned something positive about *Student Engagement* or *Student Understanding*. For teacher candidates who agreed on the multiple-choice questions, they were also positive in the open-ended question, but those who disagreed were also positive about *Student Engagement* and being a *Pedagogical Alternative*.

Student Engagement and *Student Understanding* were the two most expressed themes impacting the usefuless to student learning. All teacher candidates expressed positive remarks about the usefulness of the lesson plan on *Student Engagement*, but some teacher candidates expressed concern around the impact the lesson would have on *Student Understanding*, which matched their multiple-choice answers. However, not every time they disagreed with the lesson plan helping students learn algebra better did they express negative remarks in the open-ended question, but the one person who expressed negative remarks about student understanding in the open-ended question disagreed that the lesson would impact learning algebra. For most teacher candidates, there was a relationship between their agreement on the multiple-choice questions and being positive in the open-ended question.

In the last open-ended question, one teacher candidate mentioned the benefit of the video game on *Student Understanding*, but two teacher candidates said something negative about *Student Understanding* of Algebra concepts as a drawback. A few teacher candidates mentioned the *Lesson Plan Contents* as a benefit and drawback, and one mentioned their *Teacher Knowledge* as being a drawback. There was not a relationship between the agreement to the video game being useful and improving the quality and other drawbacks and benefits expressed.

3) Attitude Toward Use: The teacher candidates' attitude toward use was generally positive, with very few disagreeing with any question (see Table IV). The majority agreed that it would be a good idea to use the lesson in their classes, and for many of the other questions, teacher candidates were split between strongly agree and agree that the video game and computation were good ideas. All teacher candidates agreed that using the video game made the lesson plan more engaging.

In the two open-ended questions (see bottom of Table IV), the teacher candidates' attitudes were generally positive toward

TABLE III
PARTICIPANTS' PERCEIVED USEFULNESS

Perceived Usefulness	**Strongly Agree**	**Agree**	**Disagree**
Q1: I feel that using the Bootstrap: Algebra lesson plan would help me teach the Algebra concepts better.		3	3
Q2: I believe that using the lesson plan will reduce the time I would have otherwise spent preparing to teach the same Algebra concepts.		2	4
Q3: I believe that the Bootstrap: Algebra lesson would help students learn the Algebra concepts better.		3	3
Q4: I believe that the use of the Ninja Cat video game for teaching Algebra would be engaging and interesting to students.	3	3	
Q5: I think the use of the Ninja Cat video game to teach Algebra would be useful.	1	4	1
Q6: The Ninja Cat video game improved the quality of the lesson plan.	2	4	
Open-Ended Questions and Mapping to Multiple-Choice			
Q1: How do you think using the Bootstrap: Algebra lesson plan will impact your teaching (#1 and #2)?			
Q2: How do you think using the Bootstrap: Algebra lesson will impact your students' learning (#3 and #4)?			
Q3: What other potential benefits or drawbacks do you see with using the Bootstrap: Algebra lesson (#5 and #6)?			

TABLE IV
PARTICIPANTS' ATTITUDE TOWARDS USE

Attitude Towards Use	**Strongly Agree**	**Agree**	**Disagree**
Q1: I believe that it would be a good idea to use the Bootstrap: Algebra lesson in my classes.		5	1
Q2: I feel that using the Ninja Cat video game to teach Algebra is a good idea.	2	3	1
Q3: I believe that the Ninja Cat video game allows the lesson plan to be more engaging.	3	3	
Q4: I believe that it is a good idea for me to use computation to teach Algebra in future lessons.	2	2	2
Open-Ended Questions and Mapping to Multiple-Choice			
Q1: What do you think about the Bootstrap: Algebra lesson plan (#1, 2, and 3)?			
Q2: How do you feel about using computation to teach Algebra (#4)?			

video games and computation as a *Pedagogical Alternative* or *Lesson Plan Relevance* to mathematics (See Fig. 2). *Lesson Plan Quality*, *Lesson Plan Content*, and *Teacher Knowledge* also seemed to play a role in their attitude toward using the lesson plan or computation in general. Many teacher candidates said something about video games and computation being a relevant application of mathematics and that more mathematics curricula should take advantage of this practical use. Overall, their attitudes seemed to be a mix of themes expressed in their perceived ease of use and perceived usefulness, and this was the first time the theme about *Student Resources* emerged.

In the first open-ended question, many teacher candidates said something positive about the *Lesson Plan Quality*. One was very positive about the *Lesson Plan Content*, and the one teacher candidate who disagreed with using the lesson plan or video game being a good idea was negative about *Student Understanding*. One teacher candidate expressed concern for their *Teacher Knowledge*, while another expressed positive sentiments toward *Student Engagement*. Two teacher candidates' multiple-choice responses did not match their sentiments in the open-ended responses. One teacher candidate mentioned their lack of knowledge as impacting their attitude toward the lesson plan, even though they were only positive in the multiple-choice questions, and one who agreed that the video games made the lesson more engaging did not have anything positive to say. The same participant was the only one to disagree that using the lesson plan and video game would be a good idea and was primarily concerned about concepts not being made clear for student understanding.

In the second open-ended question, there were two candidates who said something negative about their *Teacher Knowledge* for using computation to teach Algebra. Four teacher candidates said something about the *Lesson Plan Relevance* to Algebra, and two of those four said that computation being a *Pedagogical Alternative* also played an important role. *Student Resources* emerged in this question as a concern for one teacher candidate. There was a relationship between the agreement to use computation and the remarks in the open-ended question about using computation to teach algebra. The teacher candidates who disagreed were also those who expressed concern about their knowledge to teach computation. Most all the teacher candidates who agreed that using computation to teach algebra would be a good idea also made positive comments about its practical application to math and being a good pedagogical alternative.

4) Behavioral Intention: Table V shows that teacher candidates were split between whether they would use the lesson plan in the future, even though the majority agreed that they would explore other lessons in the future or intended to use computation when teaching Algebra.

In the two open-ended questions (see bottom of Table V), *Student Resources* continued to be a major concern for one teacher candidate's intention to use the lesson plan or computation in the future (see Fig. 2). Many teacher candidates expressed a lot of concern with their *Teacher Knowledge* negatively impacting their intention to use the lesson or computation in the future.

TABLE V
PARTICIPANTS' INTENTION TO USE

Intention to Use	**Strongly Agree**	**Agree**	**Disagree**
Q1: I intend to use the Bootstrap: Algebra lesson plan in the future.		3	3
Q2: I plan to explore other Bootstrap: Algebra lesson plans in the future.	1	4	1
Q3: I intend to use computation when teaching Algebra.	1	4	1
Open-Ended Questions and Mapping to Multiple-Choice			
Q1: What factors are impacting your intention to use the Bootstrap: Algebra lesson plan in the future (#1 and #2)?			
Q2: What factors are impacting your intention to use computation in future Algebra classes(#3)?			

In the first open-ended question, we saw that teacher candidates' time and other *Teacher Resources* needed to use the lesson plan in the future became a factor for three teacher candidates, and *Lesson Plan Relevance* was a factor for a few teacher candidates. Only one mentioned *Teacher Knowledge*, *Student Understanding*, or *Class Curriculum Relevance* to the class they teach. There was more of a relationship between the agreement in the first multiple-choice question than the second. This was likely because the second question asked about exploring other Bootstrap lesson plans, rather than using the current lesson plan they reviewed. However, two teacher candidates who either agreed or disagreed to use the lesson plan in the future had opposite sentiments in their open-ended responses. One who agreed they would use the lesson plan in the future was negative about the time they would have to spend changing the lesson plan and the relevance of the lesson plan to math concepts, and the other who disagreed with using the lesson plan in the future was positive about its relevance and exploring other lessons in the future.

In the second open-ended question, *Teacher Knowledge* was a key factor for four teacher candidates' intention to use computation in the future, mainly because they lacked the knowledge and had not seen enough examples. One other teacher candidate made positive comments about the *Lesson Plan Relevance* of applying computation to mathematics and *Student Engagement*. Two teacher candidates who agreed to use computation in the future expressed only negative sentiments about not having enough knowledge to use computation in the future, and the same teacher candidate continued to mention *Student Resources* as a concern.

B. RQ2: What are the significant relationships among the constructs in the TAM that can help us understand teachers' intention to use a CS-based curriculum?

The three teacher candidates who disagreed with the intention to use the lesson plan in the future were the same teacher candidates who disagreed in the ease of use, usefulness, and attitude questions (see Table VI). We can also see those teacher candidates who disagreed with the intention to use the lesson plan in the future mostly disagreed on Q5 about confidence in answering student questions, Q6 about integrating into teaching practices, and Q8 about confidence using the video game in their perceived ease of use.

TABLE VI
PARTICIPANT ANSWERS TO TAM QUESTIONS

ID	Experiences		Intention			Ease of Use								Usefulness						Attitude			
	Teaching	CS	Q1	Q2	Q3	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q1	Q2	Q3	Q4	Q5	Q6	Q1	Q2	Q3	Q4
P1	None	No	D	A	A	SA	SA	SA	A	D	A	SA	D	D	D	A	SA	A	SA	A	SA	SA	D
P2	1 - 3 years	Yes	A	SA	SA	D	SA	A	A	SA	SA	SA	SA	A	A	D	SA	SA	SA	A	SA	SA	SA
P3	7 or more years	No	D	D	A	A	A	A	A	D	D	A	D	D	D	D	A	D	A	D	D	A	SA
P4	1 - 3 years	No	D	A	D	A	A	A	A	D	D	A	D	D	D	D	A	A	A	A	A	A	D
P5	None	No	A	A	A	A	A	A	A	D	A	A	A	A	A	A	A	A	A	A	A	A	A
P6	1 - 3 years	No	A	A	A	A	A	A	A	SA	A	A	A	A	D	A	SA	A	A	A	A	SA	A

They also disagreed with Q1-Q3 about the lesson plan helping them teach better, prepare less, and students learn better in their perceived usefulness. Interestingly, they were the only teacher candidates who disagreed to questions in their attitude towards use, even though they were not necessarily the same questions. Therefore, confidence in using the curriculum, the perceived usefulness for student understanding and teaching better, and attitude might play a role in the intention to use the curriculum.

C. RQ3: How do teachers' experience (EX) impact their perceived ease of use (E), perceived usefulness (U), attitude (A) and overall intention to use a CS-based curriculum?

The teacher candidates' experience with teaching or CS/computational knowledge had nothing to do with their intention to use the lesson (see Table VI). However, a teacher candidate with CS/computation experience (P2) took the longest time to go through the lesson plan and responded negatively toward *Student Understanding* and *Lesson Plan Content*. They felt they did not have enough resources and the lesson plan *"lacks vocabulary"*, which influenced their perception of usefulness where they mention that the lesson plan will not help students learn Algebra better. However, the teacher candidate with the most teaching experience (P3) had the most negative open-ended responses and expressed a negative intent to use. In their open-ended responses, they emphasized *Student Understanding*, *Student Engagement*, and *Lesson Plan Relevance*. They acknowledged that *"using computation is really important for the students to connect math to real life"*, but they believed the lesson plan *did not clarify any concepts* and would *not lead to student conceptual understanding*. While this may be attributed to their years of teaching experience, we cannot establish a direct relationship.

Participants P1 and P4 with little teaching experience did not intend to use the lesson plan (None, 1 - 3 years). Interestingly, despite liking the *Lesson Plan Quality* and *Lesson Plan Relevance*, their open-ended responses expressed negative perceptions of their *Teacher Knowledge*, with one feeling *"not very confident"* and the other being *"uncomfortable with using computation"* tool. The remaining two participants (P5, P6) with similar experience to P1 and P4 had positive responses in all questions. They disagreed with a few questions regarding their knowledge of the material, ability to answer students' questions, or the time spent preparing the lesson.

V. CONCLUSION

This study yielded valuable insights into the factors that influence the use of a CS-based curriculum. By employing the Technology Acceptance Model (TAM), we were able to identify key areas that can impact the intention to use a CS-based curriculum. Since *Teacher Knowledge*, *Lesson Plan Quality*, *Student Engagement*, *Lesson Plan Content*, *Student Understanding*, and *Pedagogical Alternative* accounted for over 70% of the responses, we believe that placing emphasis on these themes can contribute to the future development of CS-based curricula and enhance adoptability.

The teacher candidates found the Bootstrap: Algebra lesson plan to be user-friendly. However, concerns were raised about their confidence in addressing student questions and certain aspects of the lesson plan, such as vocabulary and opportunities for student exploration. These findings highlighted the importance of enhancing the development of teachers' knowledge for teaching CS within the lesson plan. While teacher candidates recognized the potential engagement and interest generated by the lesson plan, reservations were expressed regarding the connection between video game development and enhancing student understanding of Algebra. It is crucial to further examine and address these potential drawbacks and limitations while leveraging the strengths of the lesson plan to optimize its impact on student learning.

Even though teacher candidates displayed positive attitudes toward video games and computation as pedagogical alternatives, appreciating their practical application of mathematics, they also emphasized the need for additional support and resources to enhance their own teacher knowledge in effectively implementing these approaches. Addressing factors such as access to Student Resources and providing support for teacher professional development emerged as key considerations for enhancing the intention to use the lesson plan or computation in the future. Emphasizing the practical relevance of the lesson plan and its alignment with mathematics education can further strengthen positive attitudes toward integrating computation into teaching practices.

Since the study only had six participants, the findings may not fully reflect the complexities and nuances of real-world classroom settings, where additional factors such as school policies, student diversity, and resource constraints may influence teachers' adoption decisions differently. Extending the study to include more participants and in-service teachers would provide a valuable comparison of perceptions and backgrounds between pre-service and in-service teachers.

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