International Journal of Educational Management and Development Studies
Volume 3 Issue 2 June 2022
DOI: https://doi.org/10.53378/352897

Mathematics Self-Efficacy and the Use of Virtual Math Manipulatives Among Pre-Service Teachers

[1]Rency A. Arida, [2]Rose R. Andrade & [3]Rina A. Mabilangan

Abstract

In response to the COVID-19 pandemic crisis, instructors' pedagogy has been modified, and technology-based educational tools have been implemented. However, little is known about pre-service teachers' self-efficacy in mathematics and their intentions in implementing such technology. Thus, the objective of this study is to test if perceived mathematics self-efficacy is significantly related to pre-service teachers' behavioral intention to utilize virtual math manipulatives. The aim of the study was addressed through the use of a descriptive-correlational research design with sixty-nine (69) pre-service teachers. Students' mathematics self-efficacy and behavioral intention to utilize virtual math manipulatives were assessed using researcher-made questionnaires. It was discovered that a significant association exists between the respondents' content self-efficacy and their behavioral intention to utilize virtual math manipulatives as to attitude, subjective norms, and perceived behavioral control. A similar relationship exists between self-efficacy and behavioral intention to use virtual math manipulatives in terms of attitude and behavioral control. The results imply that applying virtual manipulatives is anchored on knowledge and confidence of process and purpose. Therefore, preparing pre-service teachers for the classroom through a variety of training and seminars will help them improve their mathematics self-efficacy while also increasing their intention to use virtual manipulatives.

Keywords: *Behavioral Intention, Mathematics Self-Efficacy, Virtual Manipulatives, Teaching and Learning*

Article History:
***Received**: April 3, 2022* ***Revised**: June 2, 2022*
***Accepted**: June 3, 2022* ***Published online**: June 6, 2022*

Suggested Citation:
Arida, R.A., Andrade, R.R. & Mabilangan, R.A. (2022). Mathematics Self-Efficacy and the Use of Virtual Math Manipulatives Among Pre-Service Teachers. *International Journal of Educational Management and Development Studies*, Volume 3 Issue 2, pp. 45 - 66. DOI: https://doi.org/10.53378/352897

About the authors:

[1]Teacher Candidate. College of Teacher Education. Laguna State Polytechnic University. San Pablo City Campus
[2]Corresponding author. Faculty. College of Teacher Education and Graduate Studies and Applied Research. Laguna State Polytechnic University. San Pablo City Campus
[3]Faculty. UP Rural High School. College of Arts and Sciences. University of the Philippines Los Baños

1. Introduction

As a result of the COVID-19 pandemic, changes were made to the way learning was done in the Philippines to make sure that both students and teachers were safe (Tria, 2020). Education institutions have quickly switched to online platforms and distance learning to limit the spread of the virus and get used to the new normal. The online distance learning platforms allow teachers to strengthen their pedagogical and technological skills to better serve the students. However, every educational institution must assess how successfully online learning helps students acquire high-quality outcomes-based education to keep up with the change to a new normal where students are no longer constrained to the four walls of the classroom (Basilaia & Kvavadze, 2020). For instance, the teaching of mathematics in schools makes use of a wide variety of pedagogical approaches, but one of the most prevalent approaches is the utilization of mathematical manipulatives (Carbonneau et al., 2018). Carbonneau and Marley (2012) describe manipulatives as "*physical or virtual elements that, when first-hand experienced by students, may link to an abstract mathematical idea*". The term was thought up by Moyer-Packenham and Bolyard (2016) to describe a visual representation of a dynamic mathematical object that is interactive and made possible by technology. It has all the features that can be programmed and can be changed, which help students learn.

Since digital platforms are so common in today's world, math lessons should emphasize the use of virtual manipulatives. Youmans et al. (2018) claimed that the use of manipulatives in math results to children's positive attitude and high level of conceptual knowledge. Similarly, math manipulatives allow children to actually experience abstract ideas, which impacts their cognition in unimaginable ways (Corpus & Salandanan, 2013). However, teachers' beliefs and manipulatives usability have a big impact on teachers' willingness to use virtual manipulatives in the classroom (Kim et al., 2013; Perera & John, 2020). Teachers may not want to use virtual manipulatives if they do not understand how they help students learn (Osuna et al., 2019). For this, Kukey et al. (2019) suggest that teachers should get more training on the use of virtual manipulatives. It is important to remember that future math teachers will have a big impact on how well the next generation learns. Therefore, giving emphasis on the use of virtual manipulatives among future math teachers should be prioritized. According to Bates et al. (2011), even though pre-service teachers say they are good at teaching math, they do not have enough confidence to help their students learn. This suggests that there is a complicated relationship between self-efficacy in math education and the way math is taught. Math education works best when students are confident in their math skills. However, this self-efficacy does not always dictate teachers' choices in selecting their pedagogies for helping students learn basic concepts in mathematics. Even if teachers are good at using technology, it does not mean that their students will learn well from them. Teachers should use the right technological innovations to create learning opportunities that help students learn math the most (Tabach & Trgalova, 2019). But not much research has been done on how to best use manipulatives in the classroom. Even less is known about teachers acceptance of manipulatives and its effect on their plans to use them in the classroom (Carbonneau et al., 2018).

This study focuses on the relationship between the mathematics self-efficacy of pre-service teachers and their behavioral intention to use virtual manipulatives. Complementing the study of Carbonneau et al. (2018) where self-efficacy is used as a moderating variable to examine the relationship between the respondents' perceptions of manipulatives and their planned usage, this study explores the perceptions of the pre-service teachers on their math self-efficacy and their intention to use manipulatives. Specifically, it aims to determine the students' perceived level of mathematics self-efficacy in terms of content self-efficacy and teaching self-efficacy and their behavioral intention to use virtual math manipulatives in terms of attitude, subjective norms, and perceived behavioral control. It also provides an answer to the hypothesis:

Ho: There is no significant relationship between mathematics self-efficacy and the perceived behavioral intention to use virtual math manipulatives among pre-service teachers.

2. Literature Review

2.1. Mathematics Self-Efficacy

In an academic setting, self-efficacy refers to a student's belief in his or her ability to do specific tasks (Perez & Ye, 2013). To facilitate the mathematics learning process and enhance student growth, students need to have a high level of self-efficacy (Fast et al., 2015). This is due to the fact that mathematical self-efficacy has a major impact on one's ability to perform mathematically. The ability of teachers to reflect on their previous experiences is associated with their sense of self-efficacy. More successful experiences will lead to greater self-efficacy and greater effectiveness in the classroom for teachers. Charalambous et al. (2008) found that pre-service teachers' mathematics self-efficacy is influenced primarily by their previous practices, with mentor and tutor comments and successful fieldwork experiences teaching mathematics. Simultaneously, instructional failures and negative feedback lessen respondents' self-efficacy views. Given their limited teaching experience, it seems logical that pre-service teachers' self-efficacy views would be influenced more by external influences such as comments from mathematical techniques course instructors or supervisors (Tschannen-Moran & Johnson, 2011).

Ferla et al. (2015) posited that mathematics self-efficacy indicates an individual's self-perceived confidence to successfully accomplish a particular mathematics task. Moreover, researchers distinguish two types of self-efficacy in mathematics teachers. Mathematics content self-efficacy refers to the subject knowledge and skills of the instructor, while mathematics teaching self-efficacy denotes the ability of the teachers to execute lessons in mathematics by applying their knowledge on pedagogies (Ünlü et al., 2017). Numerous research studies have revealed a favorable relationship between mathematics self-efficacy and the ability to teach mathematics successfully among pre-service teachers (Bates et al., 2011; Briley, 2012; Ünlü et al., 2018; Zuya et al., 2016). Simply put, as educators' confidence in their mathematical abilities improves, their self-efficacy as instructors rises as well. Consequently, mathematics courses have a dual purpose: to increase pre-service teachers' content knowledge of mathematics and advance their understanding of mathematics teaching approaches. One way to deal with this dual claim is to teach mathematics with the aid of manipulatives to help students visualize abstract concepts. Therefore, mathematics methods course help pre-service teachers learn more about the subject matter while also teaching them how to teach in a standard way. This is a combination that Bates et al. (2011) affirm could boost the math self-efficacy of pre-service teachers.

Students are found to exhibit a level of motivation that matches the teachers' confidence in their abilities (Mojavezi & Tamiz, 2012). Self-efficacy is a primary motivator that influences how future and current educators perceive themselves (Arnold et al., 2011). According to Lacobelli (2019), a person who lacks confidence and effectiveness in mathematics instruction lacks a thorough grasp of the topic. Similarly, Hashmi and Shaikh (2011) claimed that self-efficacy predicts the success of a teacher's mathematics instruction. As stated by Unlu et al. (2017), instructors' self-efficacy beliefs affect their students' emotions, social, and educational status, shaping their academic inclinations. According to Mji and Arigbabu (2012), the high level of self-efficacy demonstrated by their mathematics teacher may also contribute to the confidence of students in mathematics. Even though a person's confidence in their math skills affects how well they teach math, it does not change everything about how they see math and what they think is the best way to help students learn.

2.2. Behavioral Intention

Behavioral intention is the behavioral desire to continuously use and integrate technology into future endeavors (Alharbi & Drew, 2014). There is little doubt that substituting digital presentation materials for boards and chalk does not adequately cover all parts of the mathematics disciplines when incorporating technology into mathematics training. Essentially, the teacher’s desire to embrace technology integration in mathematics education should be the primary consideration. This factor encompasses the teacher’s expertise and willingness to provide better access to mathematics among their current students as a way of improving the delivery of the lesson. In contrast, Grant and Barbour (2013) assert that the sheer appearance of mobile devices does not imply that they will be used in a practical manner. In order to maximize the attainment of targeted learning outcomes, teachers' expertise and responsibility play a critical role in determining how to use technology effectively. Similarly, Solheim (2017) adds availability of the materials and teachers’ perspective that can also have an impact on student achievement. For example, schools equipped with innovative teaching tools such as computers can assist students in performing better. Likewise, engaging and attaining a higher level of achievement among students are plausible to attain if teachers are effective classroom managers.

According to Varol et al. (2012), educators should provide meaningful tasks that convey reflection and mathematical understanding to help students improve their existing skills and knowledge. They highlight the importance of teachers providing early hands-on activities to develop students' mathematical proficiency. The exercises used must be appropriate for the students' mathematics competency levels, and teachers must strive to create a conducive learning environment. The study shows that teachers who talk about real and virtual manipulatives in class help their students understand math concepts better. On the other hand, Mailizar (2021) revealed a number of characteristics that influence teachers' behavioral intention to use e-learning in their mathematics classroom, with a particular focus on instructors who have previous experience employing e-learning for professional development. According to the findings, two of the four factors that influence instructors' behavioral intention to utilize e-learning—specifically, their attitude toward and experience with e-learning—have a favorable effect on that behavioral intention. Teachers' attitudes toward e-learning are critical in determining their behavioral intentions and are positively and significantly influenced by their e-learning experience.

2.3. Virtual Manipulatives

Over the last ten years, there has been an expansion of technological innovation. The development of this technology has led to the appearance of virtual manipulatives in a variety of forms that extend beyond the online world (Moyer-Packenham, 2016). Virtual manipulatives are technologies, and like any technology, they do not create learning; rather, the quality of engagement with the technology creates learning opportunities. Bartolini and Martignone (2014) described virtual manipulatives as essential tools used in math classes. Students use them to learn, obtain, or engage in problem-solving tasks that are based on perceptual evidence and mathematical concepts or methods. Tucker et al. (2017) assert that using virtual manipulatives can help students learn math. Many of the virtual manipulatives that are currently available today were designed and modelled after their physical counterparts that are commercially available for the purpose of teaching mathematics (Moyer-Packenham, 2012). Additionally, studies that used design-based methods (Holgersson et al., 2016) and meta-analyses (Moyer-Packenham & Westenskow, 2016) provide empirical evidence that virtual manipulatives can help students learn mathematics better. Hakim et al. (2019) emphasized that virtual manipulative media can create an interactive environment so students can apply or solve mathematical problems to form links between mathematical concepts and mathematical procedures. Moreover, Moyer-Packham (2016) explained that proper application of virtual manipulatives can assist students in the formulation of mathematical ideas and the improvement of their mathematical understanding while Unamba et al. (2020) demonstrated that virtual manipulatives increased students' achievement and attitude toward mathematics instruction. These findings indicate that teachers' effective utilization of virtual manipulatives not only increases students' academic achievement but also improves comprehension. Chun and Chen (2015) revealed that using non-routine samples may improve equivalent fraction learning performance. Thus, learning with virtual manipulatives is described as generally successful, as it could raise positive attitudes and increase learning enjoyment.

In a similar study, Tucker et al. (2017) examined the 33 kindergarten kids talked to each other while using applications with early number sense or quantity in base ten math content. The results showed that students' math practices were congruent with math skills development and added new knowledge by showing kids the use of virtual math manipulatives on touchscreens. For this, Loong (2014) emphasizes that physical and virtual manipulatives can assist students understand place value, regrouping, multiplying and dividing fractions, area, and perimeter. These activities can be utilized as corrective measures for difficult students whose middle school progress is hindered by poor relational understanding. In another study by Sandir (2016), the conception and application of manipulatives by future math teachers within the context of a variety of mathematical concepts were assessed. Findings showed that it was difficult for pre-service instructors to comprehend their mathematical ideas when they were given the opportunity to do so with manipulatives. Despite the fact that the benefits of employing manipulatives in the classroom have been explored, evidence has shown that instructors' perceptions of manipulatives in the classroom are very low (Furner & Worrell, 2017). Although the causes of ineffective use of manipulatives in education has not been thoroughly investigated, literature indicates that lack of teaching experience or competence in a particular dimension is the most common reason for the poor teaching of such materials or topics.

3. Methodology

The study utilized descriptive-correlational research design. According to McCombes (2020), descriptive research describes a population, condition, or phenomenon systematically and reliably. It can answer interrogative questions, but not why. On the other hand, Walinga and Stangor (2014) describes correlational research as calculating two or more related variables and evaluating the relationship between or among them. This design appropriately describes the perception of pre-service teachers' mathematics self-efficacy and behavioral intention to use virtual manipulatives. Furthermore, this study also assesses if a significant relationship exists between the two variables.

Sixty-nine (69) respondents were chosen using purposive sampling by considering only the 2nd and 3rd year pre-service teachers from a state university in the Philippines who have taken Teaching Strategies in Mathematics as one of their major subjects. There were 34 respondents from the 2nd year (1 male and 33 females) while 3rd year level consists of only 35 females.

The study used researcher-made survey questionnaire divided into three parts: *Demographic Profile* deals with the basic information or characteristics of the respondents of the study; *Mathematics Self-Efficacy* refers to the respondents' perceived level of mathematics self–efficacy in terms of content self-efficacy and teaching self-efficacy and *Behavioral Intention* refers to respondents' behavioral intention to use virtual manipulatives in terms of attitude, subjective norms, and perceived behavioral control.

Validation. Prior to the conduct of the study, the questionnaire was examined by a panel of experts, composed of four instructors from different high school institutions and specialists, made up of three mathematics instructors and one English teacher. Furthermore, the instrument was subjected to pilot testing in order to evaluate its reliability. Based on the results of the test reliability, it was ascertained that the questionnaire had an acceptable level of reliability (Mathematics Content Efficacy=.951; Mathematics Teaching Efficacy=.938; Attitude=.894; Subjective Norms=.890; Perceived Behavioral Control=.830). Generally, a Cronbach's alpha score of 0.70 or higher is considered satisfactory in terms of internal consistency (Taber, 2018).

Following the validation of the research instruments and acceptance of the necessary letter to conduct the study from the university's respected offices, the questionnaire was disseminated through online questionnaire link to the participants. Respondents were instructed to complete the survey within a week from receipt thereof. Finally, after the three weeks of regular communication with respondents, the questionnaire was retrieved. The study ensured the data and answers provided remained anonymous and the personal information of the participants confidential.

Self-efficacy and behavioral intention to utilize virtual math manipulatives were assessed using the mean and standard deviation. Since the data is normally distributed, Pearson Product Moment Correlation was used to determine whether or not there is a statistically significant association between pre-service teachers' mathematics self-efficacy and their behavioral intention to employ virtual math manipulatives in their classrooms.

4. Findings and Discussions

Table 1

Content Self-Efficacy of the Respondents

Indicators	x̄	sd	VD
1. I can help my students value Mathematics through the use of virtual manipulatives.	3.01	0.50	High
2. I can use virtual manipulatives to motivate my students who are disinterested in Math in the classroom.	2.97	0.48	High
3. I can promote active learning using virtual manipulatives	3.04	0.55	High
4. I can provide examples using virtual manipulatives if my students get confused.	3.12	0.47	High
5. I can build connections between concepts and representations using virtual manipulatives.	3.03	0.51	High
6. I can use a variety of virtual manipulatives depending on the lessons.	3.06	0.48	High
7. I can use virtual manipulatives to improve the creativity of the students.	3.09	0.45	High
8. I can deliver my lessons easier through the use of virtual manipulatives.	2.97	0.51	High
9. I can promote fun learning using virtual manipulatives.	3.10	0.46	High
10. I can assist my students in comprehending abstract arithmetic ideas through the use of virtual manipulatives.	2.97	0.54	High
Average Mean	**3.04**	**0.40**	**High**

Legend: *3.50-4.00 = Very High, 2.50-3.49 = High, 1.50-2.49 = Low, 1.00-1.49 = Very Low*

The table indicates that the respondents have a high level of perceived content self-efficacy, with an overall mean of 3.04 and a standard deviation of 0.40, demonstrating excellent subject-matter knowledge and abilities in using virtual manipulatives. This implies that the pre-service teachers are confident in incorporating virtual manipulatives into their math classes based on their skills and knowledge of the subject. The majority of them stated that if students were confused, they could give examples using virtual manipulatives ($\bar{x}$ =3.12, sd = 0.47). Learning concepts in math is quite hard. One example is not enough for students to understand the lesson; thus, the teacher needs to provide further examples. It only indicates that, given the abstract nature of mathematics, virtual manipulatives could help students visualize the problems and examples to ease their confusion. Plute (2016) asserts that manipulatives may be a valuable tool for assisting pupils in picturing a word problem. Through virtual math manipulatives, they would understand the concepts easier and have a clearer picture of the problems given to them. Kang (2012) stated that a teacher's ability to give students real examples and situations could affect how well they do in school.

Correspondingly, despite having the lowest mean of 2.97, teacher candidates demonstrate a very satisfactory level of content self-efficacy when motivating students who are disinterested in math, delivering lessons easily, and assisting students in comprehending math concepts through virtual manipulatives. These pre-service teachers took Technology for Teaching and Learning, which helped them gain confidence in using virtual manipulatives to engage learners and motivate students to learn math. This provides them an avenue to understand its use and purpose. Solheim's (2017) affirms that the availability of resources to use and understand virtual manipulatives could make a difference in student performance. Thus, it contributed to their self-efficacy through the aforementioned course.

Table 2

Teaching Self-Efficacy of the Respondents

Indicators I am confident enough to teach…	**x̄**	**sd**	**VD**
1. the four basic operations.	3.22	0.51	High
2. value and place value.	3.25	0.55	High
3. fractions.	3.03	0.64	High
4. decimals.	3.07	0.60	High
5. ratio and proportion.	2.96	0.65	High
6. plane figures and plane mensuration.	2.99	0.65	High
7. solid figures and solid mensuration.	3.01	0.61	High
8. measurement.	3.01	0.61	High
9. integers.	2.99	0.65	High
10. graphs.	2.97	0.64	High
Average Mean	**3.05**	**0.49**	**High**

Legend: *3.50-4.00 = Very High*, *2.50-3.49 = High*, *1.50-2.49 = Low*, *1.00-1.49 = Very Low*

The table suggests that pre-service teachers had a high degree of perceived teaching self-efficacy, with an overall mean of 3.05 and a standard deviation of 0.49, showing that they are more confident in their abilities to use their content knowledge to teach children mathematics. In light of their knowledge of mathematics, this demonstrates that these pre-service teachers have a high level of confidence in presenting mathematics lessons. With a mean score of 3.25, the respondents exhibit the greatest confidence in their capacity to teach value and place value to their students. This is attributable to the fact that these topics, together with the four basic processes, should be taught to students from the very beginning of their academic careers.

Developing a conceptual understanding of the mathematical principles underpinning value and place value can be difficult for primary students. Student uncertainty, which can linger until the fourth and fifth grades if not addressed early (far earlier than the first or second grade), is preventable by providing them with the fundamental information they need to understand value and place value (Fraivillig, 2018; McGuire & Kinzie, 2013). It has been reported that classroom teachers are interested in cultivating place values by utilizing a variety of established methods with varying degrees of success. A threefold increase in the proportion of pupils who correctly recognized base-ten number concepts compared to the control group was observed when math manipulatives were used (Fraivillig, 2018).

While this is regarded as a high level of teaching self-efficacy, teaching ratio and proportion has the least mean of 2.96 and a standard deviation of 0.65. Based on the researcher's observation, the 2nd and 3rd-year BEED students have difficulty with fractions that are very relevant to ratio and proportion. To support this claim, the researcher asked the respondents' current teachers in mathematics. Based on the records, it is apparent that they have low scores in ratio and proportion, particularly in problem-solving. Additionally, Bentley and Bosse (2018) assert that college students share the same misconceptions about fraction operations as primary school pupils on fraction operations. If this issue is not fixed immediately, it is more likely to have an adverse effect on their ability to deliver the lessons effectively.

Noteworthy is that all indications of mathematics self-efficacy, both in terms of content and in terms of teaching, were evaluated as high by the respondents. This could be linked to the courses they took, which included courses such as Teaching in the Primary and Teaching in the Intermediate, among others. These topics have equipped them with sufficient knowledge and confidence.

Table 3 reveals that the majority of respondents support the use of virtual manipulatives to engage students during discussion, with the highest mean rating of 3.32. These pre-service teachers want to employ virtual math manipulatives for a variety of reasons, including attracting students' attention and encouraging them to participate in meetings. Student engagement, according to Cockett and Kilgour (2015), is higher when manipulatives are used in the classroom than when they are not used. It would appear that the vast majority of children like interacting with manipulatives, and there is evidence to suggest that manipulatives are beneficial to the formation of mathematical ideas.

Table 3

Behavioral Intention of the Respondents to Use Virtual Math Manipulatives in Terms of Attitude

Indicators I intend to use virtual manipulatives to…	**$\bar{x}$**	**sd**	**VD**
maximize the use of technology.	3.16	0.58	Agree
motivate my students.	3.26	0.61	Agree
engage my students during discussion.	3.32	0.61	Agree
introduce new topics.	3.20	0.58	Agree
foster student creativity.	3.26	0.61	Agree
give clarification whenever the students are confused.	3.23	0.55	Agree
implement alternative strategies in the classroom.	3.17	0.59	Agree
build routines that will allow activities to flow smoothly.	3.16	0.58	Agree
improve student comprehension.	3.17	0.62	Agree
give more examples when students find it hard to cope with the lesson.	3.29	0.57	Agree
Average Mean	**3.22**	**0.52**	**Agree**

Legend: *3.50-4.00 = Strongly Agree, 2.50-3.49 = Agree, 1.50-2.49 = Disagree, 1.00-1.49 = Strongly Disagree*

On the other hand, they placed a lower value on the use of virtual manipulatives to optimize the use of technology and the establishment of routines to ensure that activities ran as smoothly as possible. Zilinskiene and Demirbilek (2015) emphasized that due to technological advancement, innovations in instructional materials and tools will become more prevalent. These resources will be of great help in providing assistance to teachers in improving and enhancing their math instruction. There is little doubt that substituting digital presentation material for board and chalk does not adequately cover all parts of the mathematics disciplines when incorporating technology into mathematics training. One of the most important criteria for integrating technology into mathematics instruction is the behavior of the instructor, which includes the knowledge, willingness, and desire to enrich lessons in order to make mathematics more accessible to current students.

In general, respondents agreed that virtual manipulatives should be used because they consider them to be beneficial, as evidenced by an overall mean of 3.22 and a standard deviation of 0.52. They believe that utilizing it would be advantageous to them in the long run. According to Youmans et al. (2018), teachers strongly advocated for the use of manipulatives to aid conceptual comprehension and believed it was critical to instill positive attitudes and dispositions toward mathematics at a young age when asked about their views on early mathematics education. Additionally, in the fields of Number Sense and Numeration, Patterning, Geometry, and Spatial Sense, educators assumed that their students excelled because they received a higher frequency of instruction/exposure, used manipulatives, and were interested in or enjoyed the area of mathematics.

As shown in table 4, the majority of the pre-service teachers agreed that their desire to use virtual manipulatives is based on whether the majority of people support or oppose their use, with an overall mean of 2.99 and a standard deviation of 0.47. As more and more of their colleagues advocate for the use of virtual manipulatives in education, their desire to implement them grows as well. Using an experimental design, Ursavas et al. (2019) discovered that subjective norms had a statistically significant overall effect on pre-service and in-service teachers' behavioral intentions to use technology. Pre-service instructors, on the other hand, were far less affected by this phenomenon. In addition to this, pre-service teachers' perspectives of how technology is used in the classroom were affected by the existence of subjective standards.

Table 4

Behavioral Intention of the Respondents to Use Virtual manipulatives in Terms of Subjective Norms

Indicators I intend to use virtual manipulatives…	**x̄**	**sd**	**VD**
due to some recommendations.	3.04	0.50	Agree
for the reason that my former teachers find it compelling.	3.06	0.59	Agree
since most people in my field would push me to.	2.86	0.67	Agree
since most of my friends are using it as well.	2.96	0.60	Agree
for researchers suggest its use to enhance students' skills and performance.	3.12	0.63	Agree
because it is part of the trend.	2.94	0.64	Agree
if most of my colleagues will use them.	2.91	0.61	Agree
if my students are expecting me to do so.	2.91	0.66	Agree
if my co-teachers ask me to.	2.83	0.62	Agree
if my students will find it helpful.	3.23	0.55	Agree
Average Mean	**2.99**	**0.47**	**Agree**

Legend: *3.50-4.00 = Strongly Agree, 2.50-3.49 = Agree, 1.50-2.49 = Disagree, 1.00-1.49 = Strongly Disagree*

According to the respondents, they aim to use virtual manipulatives if the students believe them to be beneficial, as seen by the highest mean of 3.23. This demonstrates that the perspectives of students are valued by these pre-service teachers. Suh et al. (2016) underscored that with the various highlights of virtual manipulatives, the teacher can make use of this to help students using teacher scaffolding. The students then have a greater chance of grasping the lessons easily with the aid of virtual manipulatives and the guidance of their instructors. Meanwhile, they agreed to use virtual manipulatives if their co-teachers asked them to do so, with the lowest mean score of 2.83 indicating their agreement. This supports the claim of Tschannen-Moran and Johnson (2011), given their limited teaching experience, pre-service teachers' self-efficacy views should be influenced more by external inputs, such as comments from mathematical techniques course instructors or course supervisors. Although they place a high value on the viewpoints of others, there are occasions when they make the conscious decision to avoid being swayed by the perspectives of particular individuals.

Table 5

Behavioral Intention of the Respondents to Use Virtual Manipulatives in Terms of Perceived Behavioral Control

Indicators	$\bar{x}$	sd	VD
I am confident that I can use virtual manipulatives effectively in my class.	3.22	0.57	Agree
I will find ease in using virtual math manipulatives.	3.17	0.62	Agree
I am confident in providing multiple representations through virtual manipulatives.	3.14	0.55	Agree
I am fully aware of the positive effects of the use of virtual manipulatives.	3.29	0.55	Agree
I am knowledgeable enough about the different virtual manipulatives that could be used in teaching Math.	3.00	0.66	Agree
It is up to me to use virtual manipulatives depending on the topics.	3.19	0.55	Agree
I am prepared for the possible negative effects of using virtual manipulatives.	3.10	0.67	Agree
It will take a lot of time and effort to use visual manipulatives.	3.16	0.61	Agree
It would be hard to facilitate my students if I allowed them to use virtual manipulatives.	2.81	0.62	Agree
There may be complications with the availability of materials and resources needed in using virtual manipulatives.	3.06	0.57	Agree
Average Mean	3.11	0.42	Agree

Legend: *3.50-4.00 = Strongly Agree, 2.50-3.49 = Agree, 1.50-2.49 = Disagree, 1.00-1.49 = Strongly Disagree*

Delving deeper into the table 5, it could be gleaned that most respondents agreed that their intention to use virtual manipulatives is affected by their perceived ease and difficulty of using the tool, with an overall mean of 3.11 and a standard deviation of 0.42. These pre-service teachers believe that it would be easy for them to use virtual manipulatives because they already took Teaching Strategies in Mathematics, which provided them with enough knowledge regarding this strategy. Nonetheless, the majority of respondents indicated that they are completely aware of the good effects of virtual manipulatives (x = 3.29, sd= 0.55). Several subjects, including Technology for Teaching and Learning 1 and Teaching Strategies in Mathematics, may have offered sufficient information about the favorable impacts of virtual manipulatives. According to Sulistyaningsih et al. (2017), pre-service teachers should continue to develop their knowledge and abilities by implementing and developing relevant resources, materials, and technological techniques during their time at university.

It is apparent that the respondents agreed with all indicators in the behavioral intention to use virtual math manipulatives. They enjoy the concept of utilizing such materials since it would benefit not just the kids but the instructors as well. Taking online education has provided them with ideas for maximizing the use of technology in the classroom. Moreover, since they see mathematics as a complex topic, they use virtual manipulatives to mitigate its abstract character while creating an engaging and educational teaching atmosphere.

Table 6

Relationship Between the Mathematics Self-Efficacy and Behavioral Intention to Use Virtual Manipulatives

	Attitude	**Subjective Norms**	**Perceived Behavioral Control**
Content Self-efficacy	.481**	.400**	.577**
Teaching Self-Efficacy	.435**	0.151	.487**

***. Correlation is significant at the 0.01 level (2-tailed).*

On the basis of attitude, subjective norms, and perceived behavioral control, Table 6 demonstrates a statistically significant association between respondents' assessed level of content self-efficacy and their perceived behavioral intention to employ virtual manipulatives. There is evidence to suggest that as pre-service teachers' content self-efficacy increases, so does their behavioral intention to use virtual manipulatives. It is more likely that respondents will take the initiative to employ virtual manipulatives in the class discussion if they are aware of the basic method and core purpose of incorporating virtual manipulatives. It is critical that the respondents are aware of the content knowledge required for applying virtual manipulatives, as this is highly associated with the intention to employ virtual manipulatives in a classroom discussion setting.

Szabó et al. (2022) emphasized that ICT tools and online teaching methods must be prioritized in teacher training and in-service training in order to develop their digital literacy. With this skill, there would be a certainty with respect to the instructor's ability to carry out virtual manipulatives, assuming they would be in the field.

Conversely, pre-service teachers' belief in their own ability to instruct has a strong relationship with their intention to use virtual manipulatives purely for the purposes of attitude and perceived behavioral control. When pre-service teachers have high levels of teaching self-efficacy, their desire to employ virtual manipulatives increases. This is related to their attitudes toward ease and complexity, as well as their perceptions of behavioral control, among other factors. Mailizar (2021) discovered characteristics that influence teachers' behavioral intention to incorporate e-learning into their mathematics classroom, with a particular emphasis on teachers who have prior experience utilizing e-learning for professional development. The findings of this study confirmed the notion that teachers' attitudes toward and experiences with e-learning have a favorable impact on their behavioral intention to use e-learning in the classroom. The perspectives that educators hold with regard to e-learning are extremely important in the process of molding their behavioral intentions, which in turn are decided by the behavioral goals that educators have.

In contrast, there is no statistically significant association between pre-service teachers' teaching self-efficacy and the subjective norms. There is no correlation between whether or not pre-service teachers are confident in their abilities to teach mathematical topics and their desire to use virtual manipulatives in reaction to other people's opinions. Pre-service teachers do not exhibit sufficient level of confidence to effectively foster student learning despite professing efficacy in teaching Mathematics (Bates et al., 2011). This suggests that, while believing in one's ability to choose the best teaching methods to help students learn has an effect on mathematics teaching efficacy, believing in one's perceived ability to choose the best teaching methods to help students achieve does not always have an effect on mathematics teaching efficacy.

5. Conclusion

This study described the perceived level of mathematics self-efficacy among pre-service teachers, as well as their behavioral intention to employ virtual math manipulatives in their classrooms. It was discovered that the respondents are confident in their knowledge and abilities in the field of mathematics, as well as in their ability to integrate virtual manipulatives into their math classes. Additionally, it was revealed that they intended to use virtual manipulatives based on the benefits of the tool, the majority of individuals in their immediate vicinity who use the same tool, and the ease with which it could be used. As a result, it is recommended that pre-service teachers be exposed to training and seminars that will escalate their mathematics self-efficacy while also increasing their intention to use virtual math manipulatives.

Students' perceived mathematics self-efficacy as compared to content self-efficacy and behavioral intention to utilize virtual math manipulatives as compared to attitude, subjective norms, and perceived behavioral control were found to be positively significant in the study. It is more likely that respondents will take the initiative to employ virtual manipulatives in the class discussion if they are aware of the basic process and basic purpose of incorporating virtual manipulatives. However, the teaching self-efficacy of pre-service teachers is found to be highly correlated with their behavioral intention to use virtual manipulatives merely in terms of attitude and perceived behavioral control. In contrast, there is no statistically significant association between pre-service teachers' teaching self-efficacy and the subjective norms. There is no correlation between whether or not pre-service teachers are confident in their abilities to teach mathematical topics and their desire to use virtual manipulatives in reaction to other people's perspectives. It is highly suggested that preparing pre-service teachers for the classroom through a variety of training and seminars should be implemented to help them improve their mathematics self-efficacy while also increasing their intention to use virtual manipulatives. Likewise, future researchers may involve a more significant number of respondents to verify the results and conduct similar studies on students with disabilities.

References

Alharbi, S., & Drew, S. (2014). Using the technology acceptance model in understanding academics' behavioral intention to use learning management systems. *International Journal of Advanced Computer Science and Applications*, 5(1), 143-155.

Arnold, K.-H., Hascher, T., Messner, R., Niggil, A., Patry, J.-L., & Rahm, S. (2011). *Empowernment through student teaching*. Erziehungswissenschaftliche Revue (EWR). Retrieved from https://uni-salzburg.elsevierpure.com/de/publication/empowernment-durchschulpraktika-perspektiven-wechseln-in-der-lehr

Bartolini, M. G., & Martignone, F. (2014). Manipulatives in Mathematics Education. In S. Lerman (Ed.), *Encyclopedia of Mathematics Education* (pp. 365-372). Springer Netherlands.

Basilaia, G., & Kvavadze, D. (2020). Transition to Online Education in Schools during a SARS-CoV-2 Coronavirus (COVID-19) Pandemic in Georgia. *Pedagogical Research*, 5(4).

Bates, A. B., Latham, N., & Kim, J.-a. (2011). Linking Preservice Teachers' Mathematics Self-Efficacy and Mathematics Teaching Efficacy to Their Mathematical Performance. *School Science and Mathematics*, 111(7), 325-333. doi:10.1111/j.1949-8594.2011.00095.x

Bentley, B., & Bossé, M. J. (2018). College Students' Understanding of Fraction Operations. *International Electronic Journal of Mathematics Education*, 13(3), 233-247.

Briley, J. S. (2012). *The relationships among mathematics teaching efficacy, mathematics self-efficacy, and mathematical beliefs for elementary pre-service teachers*. Issues in the Undergraduate

Carbonneau, K. J., & Marley, S. C. (2012). *Activity-based learning strategies*. In J. Hattie & E. M. Anderman. (Ed.), The international guide

Carbonneau, K. J., Ardasheva, Y., & Zhang, X.S. (2018). *Pre-service educators' perceptions of manipulatives: The moderating role of mathematics teaching self-efficacy*.

Charalambous, C. Y., Philippou, G. N., & Kyriakides, L. (2008). Tracing the development of preservice teachers' efficacy beliefs in teaching mathematics during fieldwork. *Educational Studies in Mathematics*, *67*(2), 125-142.

Chun, Y, L., and Chen, M. J. (2015). Effect of Worked Examples Using Manipulatives in Fifth Grade Learning Performance and Attitude Towards Mathematics. *Educational Technology and Society*. 18 (1) 264-275

Cockett, A., & Kilgour, P. W. (2015). Mathematical manipulatives: Creating an environment for understanding, efficiency, engagement, and enjoyment. *Teach Collection of Christian Education*, 1(1), 5.

Corpus, B., & Salandanan, G. (2013). *Principles and strategies of teaching*. Lorimar Publishing Co., Quezon City, Philippines.

DesMarais, C. (2012). *15 Women to watch in tech*. Retrieved from: http://www.inc.com/ss/christina-desmarais/15-women-watch-techstartups.html#11. [Accessed January 14, 2019].

Fast, L. A. et al. (2015). Self-efficacy and standardized test performance. Accessed on November 22, 2017, of http://rap.ucr.edu/efficacy.pdf

Ferla, J., Valcke, M., Cai, Y. (2015). *Academic self-efficacy and academic self-concept: Reconsidering structural relationships*. Retrieved from: users.ugent.be/~mvalcke/CV/selfeffiacy_selfconcept.pdf

Fraivillig, J. L. (2018). Enhancing Established Counting Routines to Promote Place-Value Understanding: An Empirical Study in Early Elementary Classrooms. *Early Childhood Education Journal*, 46(1), 21-30.

Furner, J. M., & Worrell, N. L (2017). *The Importance of Using Manipulatives in Teaching Math Today*.

Grant, M.M. & Barbour, M.K. (2013). *Mobile teaching and learning in the classroom and online: Case studies in K-12*. In Z. Berge & L. Muilenburg (Eds.), Handbook of mobile learning (pp. 285–292). New York, NY: Routledge

Hakim, L. L., Alghadari, F., & Widodo, S. A. (2019). Virtual manipulatives media in mathematical abstraction. *Journal of Physics: Conference Series*, *1315*(1). https://doi.org/10.1088/1742-6596/1315/1/012017

Hashmi, M., & Shaikh, F. M. (2011). Comparative Analysis of the Effect of Teacher Education on Motivation, Commitment, and Self Efficacy. *New Horizons*, 5(2), 54-58. https://search.proquest.com/openview/c36490f3427e4dd388764134f41996b4/1?pqorigsite=gscholar&cbl=616520

Kang, O. (2012). *Teaching Mathematical Modeling in School Mathematics*. University of Southern Iowa, USA

Kim, C., Kim, M. K., Lee, C., Spector, J. M., & DeMeester, K. (2013). Teacher beliefs and technology integration. *Teaching and Teacher Education*, 29, 76–85.

Kukey, Ebru, Habibe Gunes, and Zulfu Genc (2019). "Experiences of classroom teachers on the use of hands-on material and educational software in math education." *World Journal on Educational Technology: Current Issues* 11.1 (2019): 74-86.

Lacobelli, E. (2019). *Exploring the Mathematical Confidence and Self–Efficacy of Primary/Junior Pre – Service Teachers*. Electronic Theses and Dissertations.

Mailizar, M., Almanthari, A., & Maulina, S. (2021). Examining Teachers' Behavioral Intention to Use E-learning in Teaching of Mathematics: An Extended TAM Model. *Contemporary Educational Technology*, 13(2), ep298.

McCombes, (2020). *Descriptive Research*

McGuire, P. & Kinzie, M. B. (2013). Analysis of pace value instruction and development in pre-kindergarten mathematics. *Early Childhood Education Journal*, 41(5).

Mji, A., & Arigbabu, A. A. (2012). Relationship between and among pre-service mathematics teachers' conceptions, efficacy beliefs, and anxiety. *International Journal of Education and Sciences*, 4(3), 261-270. doi:10.1080/09751122.2012.11890051

Mojavezi, A., & Tamiz, M. P. (2012). The impact of teacher self-efficacy on the students' motivation and achievement. *Theory and Practice in Language Studies*, 2, 483-491.Available at: https://doi.org/10.4304/tpls.2.3.483-491.

Moyer-Packenham, P. S., & Bolyard, J. J. (2016). Revisiting the definition of a virtual manipulative. In *International perspectives on teaching and learning mathematics with virtual manipulatives* (pp. 3-23). Springer, Cham.

Moyer-Packenham, P. S. (Ed.). (2016). *International Perspectives on Teaching and Learning Mathematics with Virtual Manipulatives* (Vol. 7). Springer International Publishing. https://doi.org/10.1007/978-3-319-32718-1

Moyer-Packenham, P. S., & Suh, J. M. (2012). Learning Mathematics with Technology: The Influence of Virtual Manipulatives on Different Achievement Groups. In *Jl. of Computers in Mathematics and Science Teaching* (Issue 1).

Osuna, J. B., Gutiérrez-Castillo, J., Llorente-Cejudo, M., & Ortiz, R. V. (2019). Difficulties in the incorporation of augmented reality in university education: Visions from the experts. *Journal of New Approaches in Educational Research (NAER Journal), 8*(2), 126-141.

Perera, H. N., & John, J. E. (2020). Teachers' self-efficacy beliefs for teaching math: Relations with teacher and student outcomes. *Contemporary Educational Psychology*, 61, 101842. https://doi.org/10.1016/j.cedpsych.2020.101842

Perez, E. D., & Ye, Y. (2013). The relationship between mathematics self-efficacy and mathematics achievement of mathayomsuksa students in the English program of st. Joseph Bangna school. *Assumption Journal*, 5(2), 82-92.

Plute, Kimberly. (2016). *The effects of cognitive strategies paired with hands-on or virtual manipulatives on math instruction for students with mathematical learning disabilities to learn word problem-solving skills*. retrieved from https://rdw.rowan.edu/cgi/viewcontent.cgi?article=2582&context=etd

Shin, M., Bryant, D. P., Bryant, B. R., McKenna, J. W., Hou, F., & Ok, M. W. (2017). Virtual manipulatives: Tools for teaching mathematics to students with learning disabilities. *Intervention in School and Clinic*, 52(3), 148-153.

Solheim, Ksenia. (2017). *Importance of teacher learning for students' achievement*. https://laringsmiljosenteret.uis.no/reseach-and-development-projects/classroom interaction-for-enhanced-student-learning-ciesl/news/importance-of-teacher-learn ing-for-students-achievement-article127646-24409.html

Suh, J.M. (2016). *Ambitious Teaching: Designing Practice-Based Assignments for Integrating Virtual Manipulatives into Mathematics Lessons*. In International Perspectives on Teaching and Learning Mathematics with Virtual Manipulatives; Springer: Cham, Switzerland.

Sulistyaningsih, D., Mawarsari, V. D., & Hidayah, I. (2017). Manipulatives implementation for supporting the learning of mathematics for prospective teachers. In *Journal of Physics: Conference Series* (Vol. 824, No. 1, p. 012047). IOP Publishing.

Szabó, É., Kóródi, K., Szél, E., & Jagodics, B. (2022). Facing the Inevitable: The Effects of Coronavirus Disease Pandemic and Online Teaching on Teachers' Self-Efficacy, Workload and Job Satisfaction. *European Journal of Educational Research*, 11(1), 151-162.

Tabach, M. & Trgalová, J. (2019). *The Knowledge and Skills that Mathematics Teachers Need for ICT Integration: The Issue of Standards*. In Technology in Mathematics Teaching; Springer: Cham, Switzerland, 2019; pp. 183–203

Taber, K. S. (2018). The use of Cronbach's alpha when developing and reporting researcher instruments in science education. *Research in Science Education*, 1273-1296.

Tria, J. Z. (2020). The COVID-19 Pandemic through the Lens of Education in the Philippines: The New Normal. *International Journal of Pedagogical Development and Lifelong Learning*, 1(1), ep2001. https://doi.org/10.30935/ijpdll/8311

Tschannen-Moran, M., & Johnson, D. (2011). Exploring literacy teachers' self-efficacy beliefs: Potential sources at play. *Teaching and Teacher Education*, *27*(4), 751-761.

Tucker, S. I., Lommatsch, C. W., Moyer-Packenham, P. S., Anderson-Pence, K. L., & Symanzik, J. (2017). Kindergarten children's interactions with touchscreen mathematics virtual manipulatives: An innovative mixed methods analysis. In *International Journal of Research in Education and Science* (Vol. 3, Issue 2, pp. 646–665). International Journal of Research in Education and Science. https://doi.org/10.21890/ijres.328097

Unamba, E., Ukeagbu, M. N, and Anulobi, A. (2020). *Effect of Virtual Manipulative on Students Achievement and Attitude in Mathematics*.

Unlu, M., Ertekin, E., & Dilmac, B. (2017). Predicting Relationship between Mathematics Anxiety, Mathematics Teaching Anxiety, Self-Efficacy Beliefs Towards Mathematics and Mathematics Teaching. *International Journal of Research in Education and Science*, 3(2), 636-645. https://eric.ed.gov/?id=EJ1148432

Ursavas, Ö. F., Yalçin, Y., & Bakir, E. (2019). The Effect of Subjective Norms on Preservice and In-Service Teachers' Behavioural Intentions to Use Technology: A Multigroup Multimodel Study. *British Journal of Educational Technology*, 50(5), 2501-2519.

Varol, F., Farran, D., Bilbrey, C., Vorhaus, E., Hofer, KG. (2012). *Professional Development for Preschool Teachers: Evidence for Practice*. https://doi.org/10.1080/15240754.2011.638742

Walinga and Stangor (2014*). Introduction to Psychology* – 1st Canadian Edition

Youmans, A., Coombs, A., & Colgan, L. (2018). Early Childhood Educators' and Teachers' Early Mathematics Education Knowledge, Beliefs, and Pedagogy. *Canadian Journal of Education*, *41*(4), 1079-1104.

Zilinskiene, I. & Demirbilek, M. (2015). *Use of GeoGebra in Primary Math Education in Lithuania: An Exploratory Study from Teachers' Perspective* https://www.researchgate.net/publication/276535780

Zuya, Habila Elisha, Simon Kevin Kwalat, and Bala Galle Attah (2016). "Pre-Service Teachers' Mathematics Self-Efficacy and Mathematics Teaching Self-Efficacy." *Journal of education and practice* 7.14 (2016): 93-98.