Review of Graduate Theses Conducted in Turkey on the Use of Technology in Mathematics Teaching

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Abstract: As developments in technology progress, their use in education in general and in mathematics teaching specifically increases. The aim of this study is to explore the potential of technology use in mathematics lessons in the schools by examining prior research on the use of technology in mathematics teaching. Within the scope of the study, a literature review was conducted to examine a total of 46 graduate theses conducted in Turkey in the last two decades. Relevant studies were accessed using search keywords such as "mathematics teaching", "geometry teaching", "technology use", and "computer supported education" through Turkish Higher Education Council's online database of graduate dissertations. The gathered theses were read in detail and summarized using an annotation method. They were categorized according to their research problems and purposes in three main groups: studies investigating the effect of technology use on students' math achievement and attitude, studies investigating consequences of technology use on students' perceptions or opinions, and meta-analysis studies of technology use in mathematics education. They used mostly experimental research methods and focused mostly on achievement and attitude. Their findings reveal that the use of technology in teaching makes mathematics lessons more enjoyable, affects students' attitudes positively, increases achievement and makes concepts more meaningful through visualization.

Keywords: Mathematics teaching, Technology use, Literature review, Graduate theses

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Introduction

Today's education approach is mostly student-centered, and teachers act as guides to students by showing them the ways to access information and help them in their constructing knowledge process. Technology has a key role in this educational approach because computers have recently become a primary and even incomparable tool used in many areas such as accessing, sharing and storing information. It is now widely-accepted that using

new technologies in the field of education enables students to appeal to more sense organs by visualizing teaching materials compared to traditional teaching methods and thus enabling more meaningful and permanent learning (Açikgöz & Akman, 2023; Akman & Açıkgöz, 2022; Cakir et al., 2019; Jonassen, Peck & Wilson, 1999; Ozturk, 2023). The use of technological materials has become essential to keep up with our age where education and technology are intertwined. In the literature review conducted by Koc (2005), it was revealed that the effective and efficient use of technology as a learning tool will show a noticeable improvements in students' achievements, interests and attitudes, communication skills, and higher-level thinking skills.

Mathematics, which has a very wide area of use, is defined as the common name of sciences such as arithmetic, algebra and geometry that examine the properties of quantities based on numbers and measurements (TDK, 2023). The science of mathematics is a symbolic language of the human mind, the transformation of abstract symbols into concrete ones. It involves processing information, generating information, making predictions, and solving problems using this language (MEB, 2018). The foundation of mathematics is based on logic and paves the way for rational thinking. According to Baykul (2003), mathematics is the tool used in daily life problems. The mathematics curriculum in Turkey aims for students to develop problem-solving skills, obtain mathematical thinking and application skills, use mathematics correctly, effectively and usefully, value mathematics and mathematics learning, and know the historical development of mathematics, the scientists who contributed to the development of mathematics and their works (MEB 2018).

Mathematics courses taught in the schools contains abstract concepts by nature. When the difficulty in perceiving abstract concepts arising from the characteristics of children's developmental levels is added to this situation, some prejudice against mathematics may occur. The integration of technology into the current school system can contribute to eliminating such prejudices that mostly due to anxiety and fear. Technology use in mathematics teaching is very important in terms of several reasons such increasing interest in mathematics lessons, reducing anxiety and fear, developing positive attitudes, increasing the success of the lesson, and more importantly, developing effective thinking habits such as analytical and critical thinking in students (Halat & Peker, 2011). With the use of new technologies, teaching mathematics may become fun, just like teaching every subject. Since the abstract concepts inherent in mathematics make teaching difficult, the desire to concretize and give meaning to these concepts has created the need to use technology in mathematics teaching. Technological tools facilitate the concretization of concepts and hence students' interest and motivation in the course increases, and teaching is facilitated by incorporating video and audio. Mathematics teaching is a very convenient field for the use of technological resources. In this context, it is important to reveal the implications that technology has for mathematics teaching in the schools.

Purpose of the Study

This study aims to analyze prior research conducted in Turkey on the use of technology in mathematics teaching in order to explore the potential of technology use in mathematics lessons in the schools, get familiar with the current research practices and trends, and make implications for future research in this field.

Method

The study was designed as a descriptive survey with document analysis as a data collection tool. The researchers conducted a literature review of master's and doctoral theses completed in Turkey in the last two decades. They accessed relevant theses through the National Thesis Center operated by the Turkish Council of Higher Education. This center regularly collects theses as an online database and makes them accessible to users via a search engine. Search keywords like "mathematics teaching", "geometry teaching", "technology use", and "computer supported education" were used to reach appropriate theses.

The researchers analyzed the theses returned from this online search through four-step content analysis. In the first step, they scanned the titles and abstracts of the theses for suitability with the scope. Then, they carefully read the full text of selected theses. Next, they created annotated summaries including research questions, method, sample, data, and results. Last, they categorized theses according to similarities and differences in their research purpose or questions under major groups.

Results

A total of 46 graduate theses were determined to be appropriate with the study purpose and included in the review. Of these, only three of them (7%) were doctoral dissertation while the rest (93%) were master's thesis. Figure 1 below presents the distribution of their years. As can be seen in the bar graph, the number of thesis tends to increase over the years with a remarkable jump as of 2010 and a fall as of 2020.

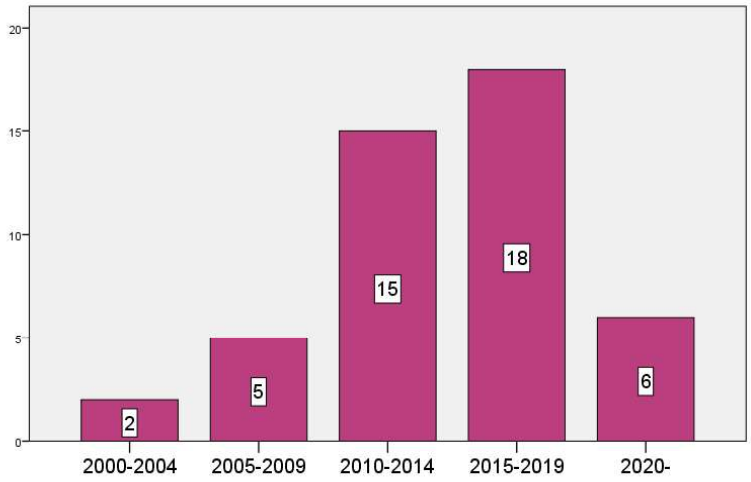

Figure 1. Years of Theses Reviewed

Regarding their research methods, the majority used experimental research design (83%), followed by survey (11%) and mixed method designs (6%). As far as their target population is concerned, most of the theses (71%) were conducted in middle schools with fifth to eighth grade students being the research participants. The rest of

the theses were conducted in high schools with ninth to twelfth graders (19%), primary schools with first to fourth graders (5%) and universities with undergraduate students (5%). Figure 2 shows the sample sizes of the research studies conducted within the theses reviewed. They preferred small sample size as the majority of them (83%) were conducted with one hundred or fewer participants. The kinds of technological applications used or focused in theses were represented in Figure 3 below. Tutoring or math related software (61%) were the most used technologies followed by presentation tools (13%), drill-and-practice software (11%), educational games (9%), interactive board (4%), simulation (4%) and video (2%).

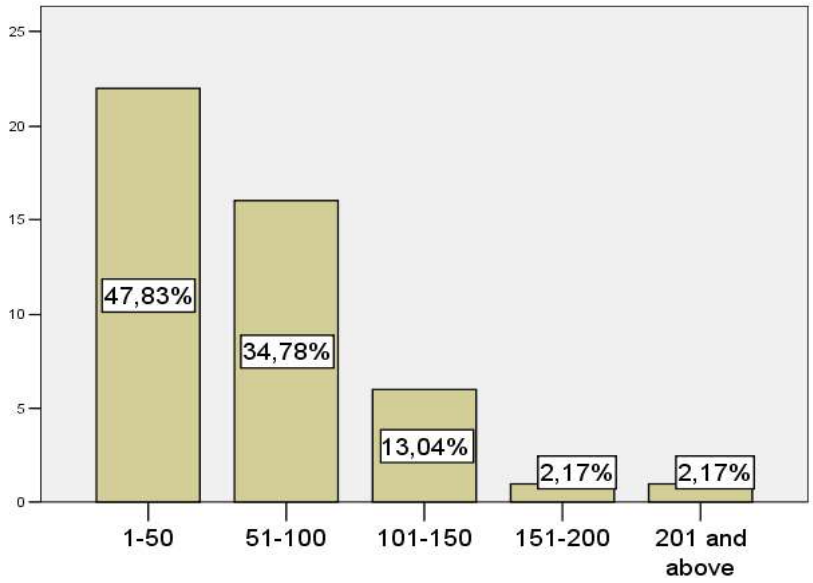

Figure 2. Sample Sizes Preferred in the Theses Reviewed

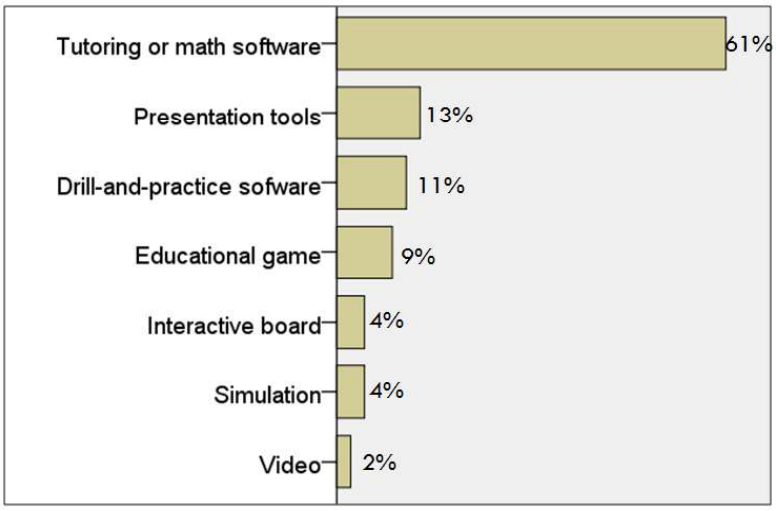

Figure 3. Technologies Employed or Focused in the Theses Reviewed

The data collection methods employed in the theses distribute as follows: tests (77%), scale (72%), interview

(22%), self-evaluation (2%) and worksheet (2%). Some of the theses used more than one of these methods together. They examined a number of variables as shown in Figure (4) including achievement (77%), attitude (46%), math anxiety (9%), self-efficacy (7%), mathematical or epistemological belief (7%), opinion (4%), reflective thinking (4%), motivation (4%), misconception about math concepts (2%), meta-cognition (2) and geometric thinking (2). Similar to data collection tools, some theses examined more than one of these variables within the same research.

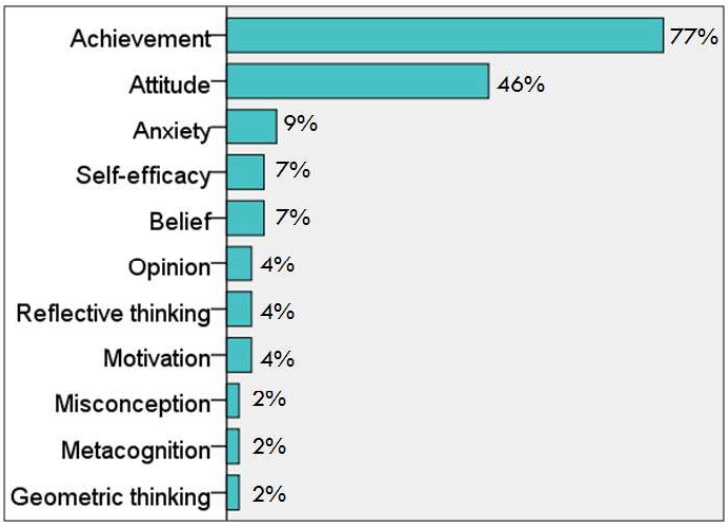

Figure 4. Variables Examined in the Theses Reviewed

The reviewed theses were categorized according to their problem statements or research questions in three groups. In the first one, there are 34 studies (74%) investigating the effect of technology use on students' cognitive and affective behaviors. The common aspect of these theses is to compare technology-supported instructions with the traditional ones in terms of various dependent variables. Thirty theses used achievement as the dependent variable and the majority (85%) reported positive effect (e.g., Acikgoz, 2018; Kuslu, 2015; Sevgi, 2020) whereas a few (15%) reported no significant effect (e.g., Bakar, 2018; Sabuncu, 2019; Tataroglu, 2009). Seventeen theses treated math attitude the dependent variable and around the half (53%) reported positive effect (e.g., Hot, 2019; Okuducu, 2020; Vahit, 2019) whereas others (47%) reported no significant effect (e.g., Sahin, 2016; Sataf, 2010; Yavuzkan, 2019). There are also some theses showing positive effect of technology use in math teaching on motivation or interest in math (e.g., Helvaci, 2010), math anxiety (e.g., Arslan, 2008), epistemological belief (e.g., Egelioglu, 2008), and geometric thinking (Ozcakir, 2013) while there are no theses showing negative effect or insignificant effect on these variables. On the other hand, few theses indicated no significant effect of technology usage in math teaching on self-efficacy (Erginbas, 2009) and metacognition (Dundar, 2015).

In the second group of the studies, there are 10 studies (22%) investigating students' perceptions or opinions about technology use in math instructions. They either revealed the current status of students' perspectives about

the use technology in mathematic lessons or described students' reflections after participating in a technology-enhanced learning activity. Based on the findings of these theses, positive student views include supporting learning complex/abstract topics through visualization (e.g., Inam, 2014; Taslibeyaz, 2010), providing engaging and entertaining learning experience (e.g., Koysuren, 2018; Zengin, 2019), enhancing interest in mathematics (e.g., Cengiz, 2017; Unluturk Akcakin, 2016), increases drill-and-practice (e.g., Simsek, 2010), saving time and thus allowing for doing various/further activities (e.g., Bayturan, 2011; Hangul, 2010;) and promoting individual/personal learning styles (Simsek, 2010). On the other hand, negative student views albeit not much comprise disrupting classroom discipline (e.g., Zengin, 2019), belief of unsuitability of technology for some math topics such as factors, roots, and calculations (Hangul, 2010) and inefficiency of technology due to technical problems such as computer/internet issues (Zengin, 2019).

In the third group of the theses, there are 3 studies (6%) conducting meta-analysis of research studies on technology use in mathematics education. They determined the overall impact of technology-supported math instruction on some variables by combining the findings of prior studies including articles, proceedings and theses with meta-analysis/synthesis method. They indicate positive and medium to large effect of technology use in math teaching on academic achievement (mean effect sizes=.68 and .93) (Demir, 2013; Uyaniksoy, 2022), positive and medium effect on problem-solving skills (mean effect size=.58) (Gursoy, 2017) and positive and small effect on math attitude (mean effect size=.46) (Uyaniksoy, 2022).

Conclusion

This review of theses conducted on technology use in mathematics teaching in the last two decades in Turkey showed that the number of thesis increased after the initiation of FATIH project, a nation-wide technology integration reform, whereas it decreased due to the COVID-19 pandemic. The reviewed studies were designed by mostly quantitative research approaches and statistical data analyses. The majority of research evidence belonged to the population of middle and high school students and gathered from small samples. Most of the research focused on the use of software specifically designed for math subjects (e.g., GeoGebra, Mathematica). Student achievement and attitude towards mathematics were over-researched variables. It has been observed that using technology-supported activities, materials and educational games in mathematics teaching is very effective in increasing academic success and positively improves student attitudes towards mathematics lessons.

In addition, using technology in math courses has been shown to facilitate easier and meaningful student learning, develop positive student perceptions about mathematics, and motivate students to study mathematics. Based on the findings of this review, it is suggested for future researchers to use qualitative research methods for detailed understanding of the potential of technology use, focus on different student populations like university students, investigate variables other than achievement and attitude, keep up with new technologies and investigate their potential in math teaching, and conduct similar reviews on other research publications such as journal articles, proceedings and so on.

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