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An approach to solving transcendental equations for high school students using technology: A case for curriculum integration

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Abstract
This article focuses on assisting teachers and students who face challenges in transcendental equations, opening new horizons for them, and enhancing their perspective on mathematics through the positive influence of technology. In this context, this article presents an approach to addressing challenging mathematical concepts with the help of math apps such as Desmos. In this way, students can enhance their understanding by visualizing solutions that would be difficult to grasp algebraically and broaden their perspectives on challenging questions. Simultaneously, interactive and didactic materials can promote students' and teachers' enthusiasm for using digital technology in the educational process. A case study revealed that both teachers and students found the graphing method for solving transcendental equations on Desmos beneficial for enhancing cognitive skills, fostering creativity, and improving teaching quality; therefore, this technique should be more prominently incorporated into the high school curriculum. This study, designed as a case study employing a mixed-methods approach, was conducted during the 2024-2025 academic school year with the participation of 24 twelfth-grade students enrolled at Stirling Girls' High School in Kirkuk, as well as four mathematics teachers working at the same school. Data were collected through the implementation of questionnaires in addition to classroom activities and interviews. The findings indicate that applying alternative approaches to the teaching of transcendental equations—topics included in the high school curriculum but often given limited emphasis—and supporting these approaches with technology resulted in a significant increase in students' academic achievement.

Keywords: graphical methods, Desmos, mathematics education, technology, transcendental equations approach

INTRODUCTION

This century has seen numerous technological and scientific advances. People's lives are affected by changes in these domains (Daskan & Yildiz, 2020). Mathematics education prepares students more easily for life in a technologically developing society. This can be achieved by allowing students to master knowledge. Mathematics should be made more meaningful by allowing students to describe mathematical concepts, relationships, and possibilities. Someone with a strong mathematical background is a valuable asset in our culture. According to Hadjinor et al. (2021), the language of mathematics is in the process of understanding and communicating itself. As a result, a teacher's role is to offer a meaningful relationship between mathematics and the real world, as problem-solving lies at the heart of mathematics.

The major purpose of mathematical studies is to improve reasoning and problem-solving abilities in advanced mathematics and other subjects. Solving various issues develops strong reasoning habits, whereas applying several solutions for a single problem promotes additional reasoning development (Jones, 2010). Mathematical thinking entails applying knowledge, analyzing, and synthesizing concepts based

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Contribution to the literature

- This study contributes to the mathematics education literature by focusing on the teaching of transcendental equations at the high school level, a topic often included in curricula but insufficiently emphasized due to its algebraic complexity.
- It provides empirical evidence on how technology-supported graphical approaches, particularly using Desmos, can enhance students' conceptual understanding and problem-solving skills.
- The study extends research on technology integration by demonstrating its effectiveness for mathematically challenging topics rather than routine procedural tasks.
- It offers insights into both student learning outcomes and teacher perspectives, enriching the literature by highlighting improvements in instructional quality and pedagogical practices.

on fundamental rules and theorems. "It involves a renewed effort to focus on seeking solutions, not just memorizing procedures; exploring patterns, not just memorizing formulas; formulating conjectures, not just doing exercises" (Schoenfeld, 1992).

Mathematics teachers must thoroughly understand pedagogical content to foster this thinking and provide meaningful learning opportunities for their students. This enables them to include various problem-solving approaches and tactics in instruction (Steele & Rogers, 2012).

Unfortunately, although the graphical method is already included in the school curriculum, it is often underutilized, overlooked, or explained through brief and simplistic questions. Yet this method has the potential to open up new horizons for students, significantly shaping their perspectives on mathematics and enhancing their love for the subject. The graphical method is typically mentioned when teaching systems of first-degree equations, where the use of technology is not necessary. Strengthening schools (Kurudirek & Berdieva, 2024) could be a point of focus for authorities to consider. However, at this stage, we aim to inspire students and broaden their horizons through this method. This approach is so effective that it can guide students toward discovering solutions, especially when tackling challenging problems. These discoveries, of course, are not achieved through ordinary questions but rather through more complex or seemingly difficult problem types, such as transcendental equations.

Scientists and engineers are frequently tasked with determining the roots of non-algebraic equations such as trigonometric, exponential, and logarithm functions. These are referred to as transcendental equations (Chapra & Canale, 2010). Transcendental equation solution has long been the primary study area in mathematical modeling, and it is critical for resolving engineering and scientific challenges. A transcendental equation is one that contains polynomials, trigonometric functions, logarithms, exponential functions, and so on. Finding the roots of an equation in the form $f(x) = 0$ is a critical challenge that requires mathematics, especially in science and engineering. Algebraically, the root of an equation $f(x) = 0$ is the value or values that x can take, assuming $f(\alpha) = 0$ for $x = \alpha$. Geometrically, the root(s) of the equation $f(x) = 0$ are located at the points where the graph of $y = f(x)$ intersects the x axis.

Although most transcendental equations can be solved without the use of general formulas, this makes obtaining analytical solutions more difficult. To solve transcendental equations like $f(x) = 0$, many traditional methods have been proposed, such as the bisection method, Newton-Raphson method, secant method, interpolation method, and Chebyshev method (Liu et al., 2022; Luck & Stevens, 2002).

Mathematics education employs a variety of apps to improve mathematical skills, such as analytical thinking, problem-solving, abstraction, and logical reasoning. The successful use of these tools adds greatly to students' mathematical competency development and provides chances for deeper understanding and application of mathematics. Integrating such technologies into mathematics instruction enables students to gain both theoretical and practical knowledge of the topic (Condor-Herrera & Ramos-Galarza, 2020). Nayıroğlu and Tutak (2024) provide the following tools and strategies for promoting interactive simulations and tailored learning pathways: Matific, Mathigon, PhET Interactive Simulations, GeoGebra, Wolfram Alpha, Maplesoft, Edmentum, Nearpod, Khan Academy, Photomath -MyScript, Mathway, Microsoft Math Solver, Edpuzzle, Amy, Smartick, Acadly, Symbolab, Cognii, Gradescope, Eduten, MATHia, StepWise Math, Plaito, Brilliant, IntMath, IBM Watson Tutor, AI Math Coach, Gauth, etc.

These tools use cutting-edge digital technology, such as artificial intelligence and metaverse platforms, to provide students with engaging, interactive, and personalized mathematics learning experiences. Each tool aims to make mathematics teaching more entertaining and successful. The application we shall discuss in this article can be briefly defined as follows.

Desmos

It is a strong graphing calculator, especially famous for its interactive visualization capabilities. Teachers can utilize Desmos to construct digital arithmetic lessons and monitor student progress (Desmos, 2024).

Mathematics, a tool utilized in many disciplines, assists individuals in developing their ability to think clearly and independently, increasing self-reliance, and explaining cause-and-effect links in difficulties they face. According to Çetinkaya (2019), students can attain the goals of teaching mathematics by gaining problem-solving skills.

Learning style describes how people feel and focus when learning, including their tempo (rapid, medium, or slow) and sensory preferences. It outlines how people comprehend, internalize, and approach the learning experience. Recognizing individual learning styles enables students to successfully process and store material in long-term memory, resulting in better outcomes (Hasibuan & Lubis, 2024).

Today, the rapid growth of technology and its impact on practically every aspect of life are hard to ignore. The education system is no exception, and it is impossible to underestimate the importance of technology in mathematical education.

Schoenfeld (2013) defines problem-solving as striving to achieve a desired goal when no known method exists. The author discusses four sorts of problem-solving behaviors that are both essential and sufficient to assess if a problem-solving attempt is successful or unsuccessful. These are individual knowledge, heuristic problem-solving approaches, self-monitoring and self-regulation, and belief systems based on students' mathematical experiences all contribute to their capacity to effectively approach and solve problems.

Integrating other courses into problem-solving allows students to see mathematics as a connected, holistic field rather than abstract, showcasing its beauty via the interaction of different areas. Novel problem-solving techniques and approaches can elicit interest and involvement. This research focuses on transcendental equations and demonstrates numerous solution approaches across mathematical themes to help high school seniors improve their pedagogical and mathematical thinking skills. Examples were provided utilizing both traditional and technology-assisted methods, and they were thoroughly explored.

This study looks into a technology-enabled method for finding the roots of transcendental equations with higher precision and convenience at the high school level. The primary goal of this article is to demonstrate how using various methods (including an approach that combines well-known classical methods for solving transcendental equations with a technologically enhanced version of a rarely used graphical method) aids in the development of pedagogical and mathematical thinking in high school students by presenting a case study conducted at Stirling Girls' High School in Kirkuk, where some of the authors teach.

Much research has been conducted on the use of technology and related apps in education, and the findings have revealed that they make varying contributions to the process. At this stage, it is vital to assess the design and impact of the interactive learning process, which allows students to contribute to the learning process while also establishing a connection to the real world. To contribute to a deeper understanding of the utility of Desmos and other technologies in education, this article tries to answer the following two research questions (RQs):

RQ1. Does using different methods assist students improve their problem-solving abilities?

RQ2. How does employing Desmos technology affect students' learning processes?

LITERATURE REVIEW

The impact of technology on students' mathematical achievement has been widely debated. Technology offers immediate feedback, allowing students to quickly correct mistakes, and has become an essential tool in teaching and learning mathematics, improving understanding and engagement (Thurm & Barzel, 2022). However, Gómez-García et al. (2020) argue that technology alone does not ensure better mathematical performance. Additionally, technology-based interventions may not suit all students and may require adjustments to align with their unique learning styles and abilities.

Technology helps students visualize abstract mathematical concepts, connect ideas, and engage actively with content, leading to increased involvement and enthusiasm for learning math (Rashidov, 2020). Gómez-García et al. (2020) found that 64% of students developed a strong interest in math through technology. As students use technology in and out of the classroom, their interest in mathematics grows. Smaldino et al. (2012) argue that integrating technology into math teaching improves students' abilities while enhancing their interest and participation. Engaged students tend to focus better, participate more, and study independently, resulting in improved understanding, problem-solving skills, and motivation (Lerkkanen et al., 2012).

Technology-enhanced mathematics learning combines digital tools, platforms, and resources to promote teaching, learning, and exploration of mathematical concepts via interactive and supportive technologies (Rahmatullayevna, 2023). Tsou and Brown (2017) discuss the benefits and problems of incorporating technology in mathematics teaching. Orhani and Çeko (2024) used a graphical method to assess the effectiveness of mobile applications for teaching linear equation systems. The findings also indicate problems and recommendations for increasing app integration in math education, which helps to better understand mobile technology's function in developing mathematical skills at the lower secondary level.

Baki (2008) emphasizes that technology-enabled teaching simplifies and accelerates learning, fixes weaknesses with feedback, promotes individual and active learning, encourages innovation and equitable possibilities, and gives students direct access to information. The association between technology use and performance is somewhat mediated by student interest, with a statistically significant link (Bright et al., 2024).

Serin (2023) investigates the transformative impact of rapidly evolving technology on mathematics education, emphasizing its role in altering teaching and learning techniques while encouraging student accomplishment. Young (2024) investigates using technology in urban mathematics teaching to overcome inequities and promote inclusive, engaging learning environments. The author emphasizes stakeholder engagement and pushes for creative strategies to empower kids and achieve educational equity and excellence in urban schools.

Kara's (2023) findings, which investigated the impact of Web 2.0 tools on students' success rates and motivation, revealed that these tools significantly increased success rates, motivation, and interactions. The study emphasized the importance of integrating these tools into education globally.

Since the 1960s, developed countries have promoted e-learning, emphasizing improving educational competencies and incorporating new technology into education. Alsamma et al. (2023) compare e-learning in Iraq to Europe and propose ideas for developing national digital platforms and improving Iraq's educational system. Using an analytical descriptive technique, the study shows Iraq's need to improve e-learning to equip students with technical skills and flexible information access. Hadjinor et al. (2021) assessed the usefulness of the Mathway Application in improving students' ability to solve trigonometric problems. Participants were positive about using Mathway. The findings imply that Mathway effectively boosts students' trigonometry performance, prompting a proposal for teachers to include innovative technology like Mathway into math instruction. Bitter and Corral (2015) propose that students use math applications to boost their mathematical learning and bridge the achievement gap between struggling and average students.

Dy (2024) assessed Desmos' usefulness as a graphing tool for teachers and students, emphasizing its benefits and students' positive attitudes toward the software. Students could interact with exercises and reflect on their learning, and they viewed Desmos as accessible, convenient, and valuable. Given our technological environment, Desmos should be extensively embraced as a teaching tool for graphing functions, assisting students in integrating technology and mathematics.

The current literature predominantly addresses methods for solving transcendental equations. Unfortunately, there is limited research on simplified forms of these equations that are easily comprehensible to high school students. Transcendental equations play a vital role in solving engineering and scientific problems. Due to their broad and profound applications, they have become a popular research topic. J.F.W. Herschel's (1792-1871) systematic approach to astronomy, charting celestial paths, illuminated the mathematical cosmos and significantly advanced scientific progress. Inspired by this insight, researchers have revisited the topic of transcendental equations, restoring the value of the graphical method while incorporating technological support. They have successfully adapted the subject to the level of high school students through a novel approach.

METHODS

Case Study

A case study conducted with high school seniors focused on solving transcendental equations using different methods. Initially, the topic was briefly introduced, followed by examples of certain polynomial equations with non-integer roots to which participants had been exposed, albeit on a small scale. This approach also familiarized them with various types of questions. It was demonstrated that each transcendental problem could be solved using different methods. Additionally, solutions could be found through graphical methods with technological support. The study was conducted at the beginning of the 2024-2025 academic school year and spanned two weeks. Presentations, sample lessons, and briefings were provided on topics such as "transcendental equations," "bisection method," "Newton-Raphson method," and "applications of technology in mathematics: Desmos." In addition to its fundamental goals, this program provided an ideal opportunity to address gaps in mathematical knowledge and, more crucially, to aid participants in broadening their teaching methods and strategies.

Participants

Our participants consisted of 24 girls from Stirling Girls' High School in Kirkuk, all of whom voluntarily participated in this study. It was clearly communicated beforehand that the evaluation outcomes would not impact their mathematics grades in any way, ensuring they could respond to the questions comfortably. Additionally, participants were assured that they could withdraw from the lessons at any time if they wished. The class of 24 presented a rich and diverse demographic profile regarding learning abilities and prior exposure to technology. The participants, aged 16-18, were enrolled in the 12^{th} grade, making them familiar with the curriculum content under investigation. In addition, four math teachers from Stirling Girls' High School in Kirkuk were requested to participate in the research, and they all replied positively.

Purpose

The case study had two primary objectives. The first was to inform participants about transcendental equations at the high school level, test their ability to solve problems through different methods, and then evaluate the impact of this strategy on their learning, thinking, and attitudes. The secondary objective was to assess the effectiveness of utilizing the graphical method—a tool they had not actively used—after gaining a certain level of knowledge about the inherently complex topic of transcendental equations supported by technology. Additionally, it aimed to examine their attitudes toward this concept. Ultimately, the goal was to open new horizons for participants, easing their journey through transcendental equations at subsequent levels of education.

Ethical Considerations

This research adhered to ethical guidelines, and informed consent was obtained from the participants and their parents or legal guardians. The study ensured the anonymity and confidentiality of the participant's responses. Additionally, the study received ethical approval from Stirling Girls' High School (dated 02.08.2024, with number E-009/No:0039).

Author's Original Transcendental Equations Approach

Researchers have noted that transcendental equations in high school mathematics are either insufficiently covered in the curriculum or not adequately emphasized by teachers. One possible explanation is the absence of such questions in standardized exams and other university entrance tests or the perception that they are too advanced for students to grasp easily. Therefore, this study aims to deepen students' understanding of the topic at the high school level.

This innovative, technology-supported approach seamlessly integrates the engaging topic of transcendental equations, making problem-solving an enjoyable experience for students. The new approach has been named the transcendental equations approach (TEA).

As a result, students will observe a practical application of the graphical method concepts covered in their school curriculum, aided by technology. This will foster a significant synergy, facilitating a quicker understanding of the subject. Fundamentally, using analytical thinking (algebraic approach) and visual strategies (graphical approach) to solve transcendental equations enhances comprehension. Various studies highlight the importance of employing multiple strategies simultaneously to improve mathematical understanding, emphasizing the role of visual strategies in fostering conceptual and lasting learning (Hegarty & Kozhevnikov, 1999; Presmeg, 1986).

TEA technique focuses on using the graphical method, supported by technology, as an effective means to solve transcendental equations, and the results are easily comprehensible to all. In applying for TEA, the following five steps are necessary:

1. **Step 1:** Ensure that the given transcendental equation is properly analyzed and confirmed to be in the form $f(x) = 0$. If not, transform it into this form.
2. **Step 2:** Divide the left side of the equation into two suitable parts, e.g., separate exponential functions, trigonometric functions, polynomials, etc.
3. **Step 3:** Label one part as $y = h(x)$ and the other as $y = k(x)$.
4. **Step 4:** With the help of technology, plot the graphs of the functions $h(x)$ and $k(x)$ using Desmos.
5. **Step 5:** Analyze the behavior of the graphs to determine the solution set.

The solutions will appear in the following ways:

- No intersection points
- One intersection point
- Two intersection points
- Multiple (finite) intersection points
- Infinite intersection points
- No real intersection points (complex solutions)

RESULTS

Phase One. Preliminary Survey

In the first phase of the study (before being exposed to a new technique for tackling slightly more difficult algebraic problems with technology support), participants in the class were asked the following question. A slightly different version was distributed to the math teachers.

Does presenting and soliciting various answers to algebraic problems with technological assistance hold any value in high schools? Kindly furnish instances that may be resolved using many methods.

Results of the preliminary survey

Over 92% of participants acknowledged the significance of presenting and resolving algebraic problems through diverse techniques. Their remarks emphasized "the significance of cultivating mathematical reasoning," "the interrelation among diverse subjects taught throughout the academic year," "fostering creativity," "a substantial learning process through which participants can enhance and deepen their knowledge while broadening their perspectives," and "advanced participants will appreciate the elegance of mathematics and relish the experience of solving a particular problem through multiple approaches that yield the same solution." Merely two participants articulated concerns, positing that "the introduction of diverse problem-solving methods complicates learning and engenders confusion," "each subject ought to be examined in isolation," or "not every student will be capable of perceiving all alternatives instantaneously or during an examination."

The most popular instances included solving quadratic equations, determining the solution set of a system of equations, and simplifying trigonometric identities. All samples were given verbally, without any further development or definition.

Phase Two. Presenting a Problem

Next, participants were given what is known as "transcendental equations" (Chapra & Canale, 2010) and asked to solve the following problem in any way possible.

Given: Find an integer root(s) of the equation $2^x - x - 1 = 0$.

Results of the second phase

The question was a challenge for the participants, and their comments were originally welcomed with silence. However, after a while, a few exceptionally talented participants began to provide answers. Although these answers were obtained through trial and error, they were indeed the correct solutions to the equation. After all, we had only asked for the answers! There had yet to be a proper step taken towards the solution.

Phase Three. Introducing Different Methods

Later, additional methods were introduced to the participants. With the teacher's support, one student gathered enough courage to come to the board and attempt to express something about the problem using classical algebraic methods. Although the student performed some operations using logarithms and the derivative operator, it became clear that with high school-level knowledge, progress could only be made to a certain point, and ultimately, dead ends were encountered. Without going into too much detail, the Bisection and Newton-Raphson methods were demonstrated to the participants superficially, emphasizing the logic behind the methods. Simple and concise examples were solved. Afterwards, a discussion was held where the participants were asked to select the method or methods they thought provided the most elegant and simplest solution. They were also asked to express their thoughts on the significance and contribution of solving a transcendental equation using various methodologies.

Results of the third phase

The participants seemed to be quite impressed by the solution methods demonstrated for transcendental equations. Out of the 24 participants, 20 preferred the Bisection method, stating that it was "more understandable and therefore easier." The remaining 4 participants, feeling more confident with derivatives, opted for the Newton-Raphson method, even though it required more steps and was more complex. They mentioned that this method would provide more reliable and robust answers.

Phase Four. Introducing Desmos

The participants were informed that other methods were available for solving transcendental equations. In addition, they were introduced to the graphical method, which they were already familiar with but had not yet used at the desired level. Simple linear equation system examples were given, and participants were asked to solve them on the board (with a volunteer student) and then in their notebooks. It was observed that all participants successfully solved this problem. Similarly, it was explained that this graphical method could be applied in various fields, one of which is transcendental equations. After presenting the TEA method, a brief Desmos training was provided. Then, the solution to the given transcendental equation was demonstrated using Desmos with technological support. A debate ensued in which participants were prompted to choose the technique or methods they deemed to provide the most elegant and straightforward solution and to articulate their views on the significance and advantages of addressing transcendental equations through several approaches.

Results of introducing Desmos

After being introduced to multiple ways of solving transcendental equations, the participants' attitudes improved, and they recognized the value of employing various mathematical tools to solve complicated issues. Undoubtedly, Desmos took the highest share in this process. Many participants openly expressed their surprise with exclamations like, "wow, that was so easy, is that all?" The smiles on some of their faces created unforgettable memories of the happiest moments a teacher can experience.

Final Phase. Face-to-Face Interviews

In the study's final phase, eight randomly selected students were interviewed in structured interviews with five questions. These interviews allowed participants to share ideas beyond the initial survey and discuss their personal experiences with the problem.

We report two of them here:

1. What do you think is the value of offering multiple solution methods for transcendental equations? Do you think that putting in effort is worthwhile?
2. Does using technology (Desmos) help students improve their problem-solving skills?

Examination of the initial interview inquiry, combined with survey results, confirmed the hypothesis that solving problems with multiple methods fosters innovative thinking. While each concept supports different aspects of mathematical thinking and creativity, strong connections between categories were evident, with many participants expressing ideas spanning multiple areas.

Analysis of the Second Interview Question

All participants unanimously expressed that they could not believe the innovation they saw with Desmos. They shared their excitement about rediscovering the graphing method for transcendental equations, which, though initially appearing challenging, could be solved through various methods. They emphasized the enjoyment of the flexible, creative, and engaging process. They pointed out that "this method is not only short and concise, requiring fewer operations, but also presents the result in a clearer way, making it more helpful than other methods."

Some gifted students also mentioned:

> At least with the help of Desmos, we can solve transcendental equations more easily and find the answer. If we later need to solve it with other methods, we can proceed more confidently in terms of mathematical operations because we already know the correct answer.

Additionally, some clever students raised the question and shared information: "Will our teachers allow us to use Desmos during exams?" If that is not the case, they felt that they would need to focus more on other methods.

Of course, since this topic is not currently included in the high school curriculum, we cannot say much about it. However, we can certainly suggest to policymakers and curriculum developers that topics like transcendental equations, where multiple solution methods can lead to results, should not overlook the possibility of technology-supported solutions.

Course Feedback Summary

Completion assessment

Along with this study, feedback related to our two-week sessions was collected through post-training evaluation forms. Lessons that included multiple solution methods received relatively high ratings: the average evaluation score was 9.5 (out of 10), and participants expressed a high level of satisfaction with both the training and the researchers in the open-text section. This positive feedback underscores the effectiveness of using diverse solution strategies in teaching and highlights the participants' appreciation for the variety of methods provided during the sessions.

Additional Mathematics Teachers' Survey

As previously said, four of our colleagues at the same high school also responded to the initial request. We sent them a survey that included the questions we created and their responses. All our colleagues were enthusiastic about the transcendental equation solution methods and the extensive mathematical knowledge required. They all agreed on the need to address problems in numerous ways. One participant stressed that first attempts to solve these types of challenges might fail:

> But if you realize there are other methods to tackle a problem, you will not let your initial attempt fail you; instead, you'll look for ways to improve. This influences their nature. This pedagogical component is crucial in mathematical endeavors!

"Solving transcendental equations in multiple ways allows for comparing and assessing pros and cons," another instructor said on approach evaluation. To rephrase, from a pedagogical standpoint, it does more than only apply information; it also involves assessment, the highest level of Bloom's taxonomy. Bingölbali (2011) noted that just because a teacher believes passionately in the value of certain solution techniques does not imply they would really use them in the classroom.

One of the teachers stressed the concept of mathematical creativity, stating that many techniques illustrate mathematics' fluency, flexibility, originality, and attraction. They also emphasized the significance of exploring alternative ideas in the classroom. It was noticed that participants were required to review and strengthen their mathematics knowledge.

The graphing method, which they had always taught and passed over quickly, was now seen as an approach that could simplify problems considerably, especially with the support of technology. Many participants highlighted the educational benefits that emerged from attempting to solve a math problem in multiple ways. They mentioned that sometimes solving a mathematical problem in two different ways can be more effective than solving ten problems using a single method.

Various interpretations of the widely used expression "develop flexible thinking" included comments such as "transforms theoretical knowledge into practice," "enhances the teacher's ability to generate interest in the classroom," and "improves the teacher's ability to encourage curiosity and research skills in students."

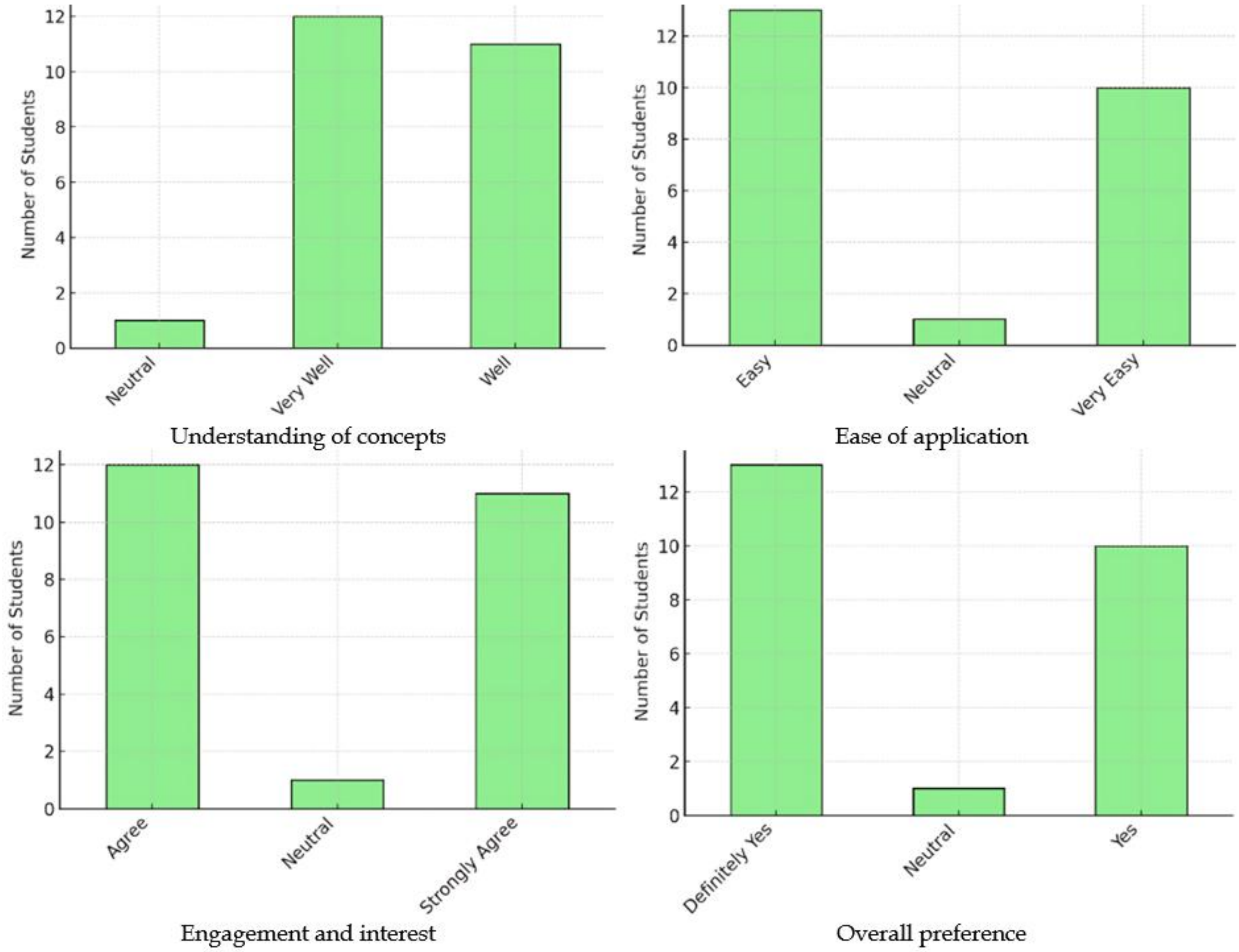

Figure 1. Effectiveness of the TEA method (Source: Authors' own elaboration)

Most educators highlighted the "visual representation" and the "great power of mathematics" offered by Desmos. The case study demonstrates that solving transcendental equations using various methods is critical for students and teachers. The technology-supported graphing method (Desmos) was particularly striking among these methods. These different methods not only enhance mathematical thinking for everyone but also enrich pedagogical approaches for teachers, offering opportunities to differentiate teaching strategies, showcase the beauty and aesthetics of mathematics, and reveal the power of mathematics through connections between mathematical topics (Dreyfus & Eisenberg, 1986; Sinclair, 2011).

Quantitative Data

To further validate the findings of our case study, a four-question survey (**Appendix A**) was also administered for the participants. The findings obtained from this survey are presented in the graphs below. The TEA approach was favorably welcomed, with consistently high ratings on all survey items. 95% of participants reacted affirmatively, suggesting great support for the TEA approach. The low standard deviations indicate that most participants had similarly pleasant experiences. These findings provide solid evidence that the TEA approach is helpful for teaching transcendental equations. The bar charts vividly highlight the method's success and demonstrate a clear preference among participants. You may see the quantitative data on the effectiveness of the TEA method (**Figure 1**).

Students' Works

After completing the lessons, participants were given transcendental equation examples with different content (detailed in the **Appendix A**). Although these questions initially seemed challenging for participants, after grasping the TEA method, some student solutions to these example questions are presented in **Figure 2**, **Figure 3**, and **Figure 4**.

DISCUSSION

In the first phase, which consisted of a preliminary study, more than 92% of the participants acknowledged

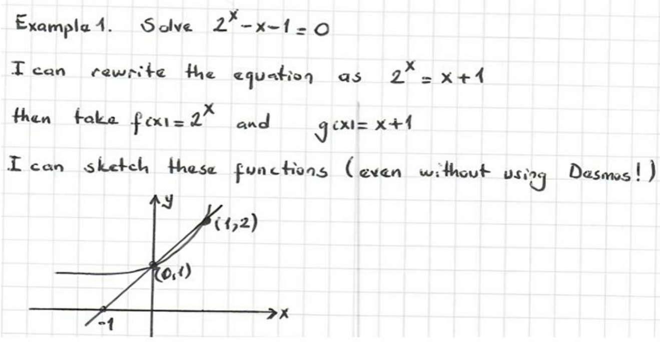

Figure 2. Student A's solution (Source: Authors' own elaboration)

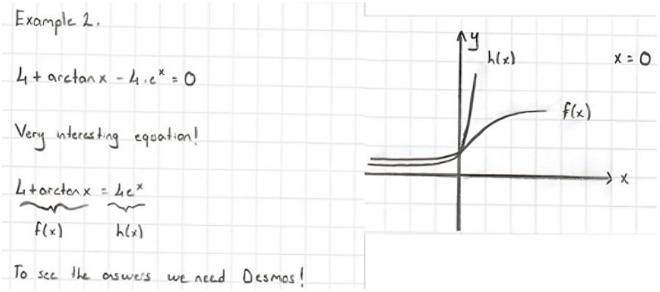

Figure 3. Student B's solution (Source: Authors' own elaboration)

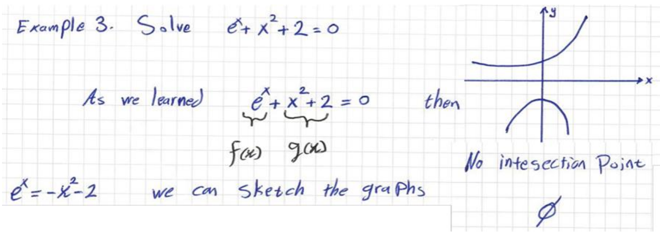

Figure 3. Student C's solution (Source: Authors' own elaboration)

the importance of presenting and solving algebraic problems using a variety of techniques. However, in the subsequent phase, despite the presence of some responses from a few talented students—identified as being obtained through trial and error—the first serious negative outcomes were observed when students encountered transcendental equations.

In the following stages, additional methods were introduced to the students. Among these, 83% of the participants found the bisection method to be clearer and easier to understand, whereas the Newton-Raphson method did not attract much interest. As Schoenfeld (2013) pointed out, an individual's belief systems (about themselves, mathematics, and problem-solving) and their origins lie within students' mathematical experiences, a view that has also been observed in our studies.

In the final stage, students were reminded of the graphical method, with which they were already familiar, for solving transcendental equations. When the procedures were carried out with the support of Desmos, all participants expressed satisfaction. At the end of the course, the average evaluation score was 9.5 out of 10, indicating results that strongly supported the RQs. Our findings were similar to those of Lerkkanen et al. (2012), who found that students are more likely to pay attention in class, participate actively, and engage in self-study when focused on a specific issue.

During our research, we found nothing contradictory to Rahmatullayevna's (2023) conclusions. She claims that incorporating technology into mathematics allows for personalized learning, interactive experiences, visualizations, and real-world applications, increasing engagement, conceptual understanding, and access to a wide range of resources and tools.

In addition, the quantitative data showed that 95% of the students evaluated the TEA method very positively. Finally, the results obtained from four mathematics teachers at the school indicate that addressing this research study seriously within the school curriculum would significantly contribute to improving both teachers' and students' perspectives on mathematics. We believe that Serin's (2023) ideas, which we can recommend for our study, contain aspects on which we can all agree without reservation. He believes that the use of technology in mathematics teaching has the potential to transform the educational process and improve student achievement. However, it is critical to address challenges such as the digital divide and give teachers the necessary support and training. With careful implementation strategies and sensible evaluation procedures, technology can help kids get a full understanding of mathematics, strengthen critical thinking skills, and prepare for success in an increasingly digital environment.

Our findings align completely with Dy (2024), and since we live in the technological age, Desmos should be actively used, tested, and considered appropriate as a teaching tool for graphing functions to help students grasp technology through mathematics. We agree with mathematics educators that using multiple approaches to solve problems and connecting mathematical ideas is essential for the development of mathematical reasoning (Stupel & Ben-Chaim, 2017). Furthermore, it is important to confirm our shared findings, which highlight the surprising rarity with which students encounter different solution methods for a given problem within mathematical topics. Therefore, we also share the common view that in-service training programs for mathematics teachers on these topics are necessary and that such topics should be included in the school curriculum.

Starting with the family, which is the smallest circle, and extending to the broader society (where everyone with influence, including those in the media, factories, crowded bus terminals, or small cafes engaging in conversation, should be included), we must reduce negative attitudes towards mathematics. Public service announcements should emphasize the value of math, and efforts should be made to foster a love for it in society. A collective initiative should be launched, and schools must be strengthened to produce students who can contribute effectively to society (Kurudirek & Berdieva, 2020).

Creative and Unconventional Thinking

Leikin (2009) highlights that diverse solution methods promote fluency, flexibility, and novelty in school mathematics. Novelty, crucial to scientific and technological innovation, arises from originality and new perspectives (Sternberg, 2004). In this study, novelty emerged as students explored solutions from different mathematical fields or previously learned perspectives, enriching their problem-solving repertoire. Many found this approach refreshingly new, as reflected in typical interview responses. During the interviews, a common response was, "I was motivated to experiment with novel problem-solving strategies for transcendental equations." Occasionally, they proved to be ineffective, necessitating that I seek alternative mathematical methodologies. Or

> After learning two successful problem-solving methods, I assumed there couldn't be any more. When I learned another one, and then heard there could be more, you can imagine my astonishment. Actually, the math in these methods seemed familiar to me, but at first, it never occurred to me to try them in this context.

This highlights how the exposure to multiple methods and the ability to explore new problem-solving strategies can promote innovative thinking, making students more adaptable and resourceful in their mathematical endeavors.

The Association Between Mathematical Domains

The importance of connections between different areas of mathematics naturally emerged for students, as many highlighted this in the first phase of the study. Multiple solutions for a transcendental equation illustrate these connections, showing that mathematics is an interconnected discipline rather than a collection of isolated topics (Stupel & Ben-Chaim, 2013). One student expressed in an interview that demonstrating multiple solution methods highlighted the relationship between various mathematical areas. A different student remarked, "This exercise enabled me to perceive mathematics not as fragmented components but as an integrated whole." This reflects a deeper understanding among students, as they began to see mathematics as a unified subject rather than a series of disconnected topics. This perspective can foster a more comprehensive approach to problem-solving and may help students apply their knowledge more creatively across different areas.

Pliable

Flexible thinking and the development of different understandings are crucial for mathematical development, as they help students approach mathematical concepts from various perspectives. Flexible thinking is important not just for students but also for mathematicians who approach problems from several angles, as it is frequently regarded as a sign of creative potential (Runco & Acar, 2012).

As seen by the early survey results, many students underlined the necessity of employing diverse ways to solve issues and develop mathematical thinking during the study's first phase. However, after gaining real experience in exploring different methods, as shown in the interviews, they became even more aware of its benefits. Students articulated concepts including "It cultivates cognitive skills for both students and educators," "We acquired significant pedagogical strategies to motivate ourselves to enhance our knowledge and expand our perspectives," "It fosters adaptive thinking and advanced cognitive abilities," and "Engaging and intellectually stimulating ... more captivating."

These insights indicate that when students are encouraged to explore multiple solution methods, they not only strengthen their understanding of the material but also develop important cognitive skills like problem-solving, critical thinking, and creativity. This flexibility in thinking is a vital skill that can lead to deeper mathematical understanding and a greater appreciation for the interconnectedness of mathematical concepts.

Ingenuity

The value of originality in mathematics is obvious, and promoting mathematical creativity in students is critical. The initial strategy is to aid educators in comprehending the integration of creativity into the learning process (Beghetto & Kaufman, 2009). When participants realized that varied solution strategies could lead to inventive ideas, they most immediately associated this with the concept of creativity. This connection was especially evident during the interviews. Participants highlighted that the "potential of different solution methods to foster, encourage, and contribute to creativity" was crucial. An outstanding teacher shared, "It is very appropriate for teachers to develop different methods to reach the goal of fostering mathematical creativity." These observations reflect the powerful link between creative problem-solving and mathematical thinking. By exploring diverse approaches to solving problems, students not only improve their technical skills but also cultivate their ability to think outside the box, which is a key aspect of mathematical creativity.

Encouraging this type of thinking is essential for enhancing students' problem-solving capabilities and their overall mathematical understanding.

Pleasure: Apart from the "cognitive" aspects mentioned above, students also noted that solving transcendental equations using different methods was "very enjoyable" and gave them an opportunity to "see the beauty of mathematics." This highlights the importance of providing students with diverse approaches to problem-solving, as it not only enhances their technical skills but also fosters an appreciation for the elegance and creativity inherent in mathematical thinking. By exploring multiple methods, students can experience the joy and satisfaction that comes with uncovering the various ways mathematics can be applied and understood. This sense of enjoyment can be a powerful motivator for deeper engagement and learning in mathematics.

Limitations

Several limitations of this study should be acknowledged, even though its findings are promising. First, the research was conducted in a single school with a relatively small number of participants. This specific setting restricts the generalizability of the results to other schools, areas, or educational systems.

Second, the group of participants was not diverse in terms of gender, consisting only of girl students. While this approach allowed for a controlled examination of the research variables, it limited the ability to explore potential gender-based differences in learning processes, attitudes, or outcomes. Future studies that include mixed-gender samples could provide a more complete understanding.

Additionally, the intervention's duration was relatively short, lasting only two weeks. Although meaningful findings were obtained during this time, a longer implementation might lead to more significant and lasting effects on students' understanding of concepts, problem-solving skills, and attitudes towards mathematics.

CONCLUSION

Students who love music, physical education, or other branches of art can also fall in love with mathematics. If there is a lack of this love or if it doesn't last long, we must first look at ourselves and our position before drawing any conclusions. The teacher should reflect on their own practices and identify the reasons. They should be willing to update themselves. In focusing on student-centered education, the teacher must also make use of technology. It is essential to remember that they are teaching the Z and Alpha generations. The teacher should seek out in-service seminars that contribute to their own professional growth.

Both students and teachers agreed that solving problems in multiple ways is beneficial in developing all students' thinking abilities, encouraging creativity, and improving teaching quality—hence, the TEA should be included in school curricula and teacher training programs. These findings are useful for educators and curriculum creators because they shed light on students' opinions of the TEA, which may drive instructional strategies and curriculum design to address these problems better. Further research and discussion of these findings may provide insights into how to improve the teaching of the TEA technique in high school mathematics.

To summarize, the findings of this study provide important insights into students' present understanding of the issue under examination. The findings indicate that efforts should be made to improve students' overall performance in this area, possibly through curricular upgrades, focused interventions, or new teaching practices. Addressing the identified performance gaps would help us provide a more effective and equitable education for all kids. The findings highlight the importance of individualized instructional techniques and curriculum development to address these perceived problems, improving middle school students' understanding and engagement with the transcendental equation.

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REFERENCES

Alsamma, M. A. J., Aljalely, A. H. A. H, & Al-Taib, A. S. S. (2023). Improving the reality of e-learning and digitization in Iraq. *Tikrit Journal of Administrative and Economic Sciences, 19*, 59-72. https://doi.org/10.25130/tjaes.19.SP3.2.4

Baki, A. (2008). *Kuramdan uygulamaya matematik eğitimi* [Mathematics education from theory to practice]. Harf Eğitim Yayıncılık.

Beghetto, R. A., & Kaufman, J. C. (2009). Do we all have multicreative potential? *ZDM Mathematics Education, 41*, 39-44. https://doi.org/10.1007/s11858-008-0143-7

Bingolbali, E. (2011). Multiple solutions to problems in mathematics teaching: Do teachers really value them? *Australian Journal of Teacher Education, 36*(1), 18-31. https://doi.org/10.14221/ajte.2011v36n1.2

Bitter, G. G., & Corral, A. (2015). Analysis of learning outcomes from mobile mathematics applications. *International Journal for Innovation Education and Research, 3*(3), 177-190. https://doi.org/10.31686/ijier.vol3.iss3.337

Bright, A., Welcome, N. B., & Arthur, Y. D. (2024). The effect of using technology in teaching and learning mathematics on student's mathematics performance: The mediation effect of students' mathematics interest. *Journal of Mathematics and Science Teacher, 4*(2), Article em059. https://doi.org/10.29333/mathsciteacher/14309

Çetinkaya, L. (2019). The effect of problem-based mathematics teaching on success through mobile applications. *Education and Science, 44*(197), 65-84. https://doi.org/10.15390/EB.2019.8119

Chapra, S. C., & Canale, R. P. (2010). *Numerical methods for engineers*. McGraw-Hill.

Condor-Herrera, O., & Ramos-Galarza, C. (2020). The impact of a technological intervention program on learning mathematical skills. *Education and Information Technologies, 26*(2), 1423-1433. https://doi.org/10.1007/s10639-020-10308-y

Daskan, A., & Yildiz, Y. (2020). Blended learning: A potential approach to promote learning outcomes. *International Journal of Social Sciences & Educational Studies, 7*(4), 103-108. https://doi.org/10.23918/ijsses.v7i4p103

Desmos. (2024). Desmos graphing calculator. *Desmos*. https://www.desmos.com/calculator

Dreyfus, T., & Eisenberg, T. (1986). On the aesthetics of mathematical thought. *For the Learning of Mathematics, 6*(1), 2-10.

Dy, A. C. (2024). Implementation of DESMOS as a teaching tool in graphing functions in the new normal. *Journal of Research and Investigation in Education, 2*(2), 59-64. https://doi.org/10.37034/residu.v2i2.175

Gómez-García, M., Hossein-Mohand, H., Trujillo-Torres, J. M., Hossein-Mohand, H., & Aznar-Díaz, I. (2020). Technological factors that influence the mathematics performance of secondary school students. *Mathematics, 8*(11), Article 1935. https://doi.org/10.3390/math8111935

Hadjinor, S. I., Asotigue, A. B., & Pangandamun, J. A. (2021). Solving trigonometric problems using Mathway application in teaching mathematics. *Asian Journal of Research in Education and Social Sciences, 3*(3), 87-97.

Hasibuan, N. S., & Lubis, M. S. (2024). The influence of digital literacy and learning styles on students' mathematics learning outcomes. *Unnes Journal of Mathematics Education, 13*(1), 36-45. https://doi.org/10.15294/ddnmx969

Hegarty, M., & Kozhevnikov, M. (1999). Types of visual-spatial representations and mathematical problem-solving. *Journal of Educational Psychology, 91*(4), Article 684. https://doi.org/10.1037/0022-0663.91.4.684

Jones, K. (2010). Linking geometry and algebra in the school mathematics curriculum. In Z. Usiskin, K. Andersen, & N. Zotto (Eds.), *Future curricular trends in school algebra and geometry* (pp. 203-215). Information Age Publishing. https://doi.org/10.1108/978-1-61735-008-520251019

Kara, S. (2023). The effects of Web 2.0 tools on foundation English students' success rates at a private university in Iraq. *International Journal of Social Sciences & Educational Studies, 10*(1), 22-36. https://doi.org/10.23918/ijsses.v10i1p22

Kurudirek, A., & Berdieva, O. (2024). The more empowered schools, the more fruitful students. *Educenter: Jurnal Ilmiah Pendidikan, 3*(1), 1-9. https://doi.org/10.55904/educenter.v3i1.921

Leikin, R. (2009). Exploring mathematical creativity using multiple solution tasks. In R. Leiken, A. Berman, & B. Koichu (Eds.), *Creativity in mathematics and the education of gifted students* (pp. 129-135). Sense Publishers. https://doi.org/10.1007/s10857-012-9229-9

Lerkkanen, M. K., Kiuru, N., Pakarinen, E., Viljaranta, J., Poikkeus, A. M., Rasku-Puttonen, H., Siekkinen, M., & Nurmi, J. E. (2012). The role of teaching practices in the development of children's interest in reading and mathematics in kindergarten. *Contemporary Educational Psychology, 37*(4), 266-279. https://doi.org/10.1016/j.cedpsych.2011.03.004

Liu, J., Wang, G., Li, W., Sun, L., Zhang, L., & Yu, L. (2022). Transcendental equation solver: A novel neural network for solving transcendental equation. *Applied Soft Computing, 117*, Article 108425. https://doi.org/10.1016/j.asoc.2022.108425

Luck, R., & Stevens, J. W. (2002). Explicit solutions for transcendental equations. *SIAM Review, 44*(2), 227-233. https://doi.org/10.1137/S0036144501386111

Nayıroğlu, B., & Tutak, T. (2024). The role of artificial intelligence in mathematics teaching: Analysing the tools used in education. *Turkish Journal of*

Educational Studies, 11(1), 65-78. https://doi.org/10.33907/turkjes.1415591

Orhani, S., & Çeko, B. (2024). Mobile applications as aids for solving systems of linear equations with two variables using the graphical method. *International Research Journal of Science, Technology, Education, and Management, 4*(2), 14-34. https://doi.org/10.5281/zenodo.12730175

Presmeg, N. C. (1986). Visualisation and mathematical giftedness. *Educational Studies in Mathematics, 17*(3), 297-311. https://doi.org/10.1007/BF00305075

Rahmatullayevna, A.M. (2023). Technology-enhanced learning (TEL) in teaching mathematics at Lyceums. *Spectrum Journal of Innovation, Reforms and Development, 22*, 272-276.

Rashidov, A. (2020). Use of differentiation technology in teaching mathematics. *European Journal of Research and Reflection in Educational Sciences, 8*(7), 163-167.

Runco, M., & Acar, S. (2012). Divergent thinking as an indicator of creative potential. *Creativity Research Journal, 24*(1), 66-75. https://doi.org/10.1080/10400419.2012.652929

Schoenfeld, A. H. (1992). Learning to think mathematically: Problem solving, metacognition, and sense-making in mathematics. In D. Grouws (Ed.), *Handbook for research on mathematics teaching and learning* (pp. 334-370). Macmillan. https://doi.org/10.1108/978-1-60752-874-620251019

Schoenfeld, A. H. (2013). Problematizing the didactical triangle. *ZDM: The International Journal on Mathematics Education, 44*(5), 587-599. https://doi.org/10.1007/s11858-012-0395-0

Serin, H. (2023). The role of technology in mathematics education: Promoting student achievement. *International Journal of Social Sciences & Educational Studies, 10*(2), 390-395. https://doi.org/10.23918/ijsses.v10i2p390

Sinclair, N. (2011). Aesthetic considerations in mathematics. *Journal of Humanistic Mathematics, 1*(1), 2-32. https://doi.org/10.5642/jhummath

Smaldino, S. E., Lowther, D. L., & Mims, C. (2012). *Instructional media and technology for learning*. Pearson.

Steele, M. D., & Rogers, K. C. (2012). Relationships between mathematical knowledge for teaching and teaching practice: The case of proof. *Journal of Mathematics Teacher Education, 15*, 159-180. https://doi.org/10.1007/s10857-012-9204-5

Sternberg, R. J. (Ed.). (2004). *Handbook of creativity*. Cambridge University Press.

Stupel, M., & Ben-Chaim, D. (2013). One problem, multiple solutions: How multiple proofs can connect several areas of mathematics. *Far East Journal of Mathematics Education, 11*(2), 129-161.

Stupel, M., & Ben-Chaim, D. (2017). Using multiple solutions to mathematical problems to develop pedagogical and mathematical thinking: A case study in a teacher education program, *Investigations in Mathematics Learning, 9*(2), 86-108, https://doi.org/10.1080/19477503.2017.1283179

Thurm, D., & Barzel, B. (2022). Teaching mathematics with technology: A multidimensional analysis of teacher beliefs. *Educational Studies in Mathematics, 109*(1), 41-63. https://doi.org/10.1007/s10649-021-10072-x

Tsou, C., & Brown, E. (2017). Implementing technologies in the mathematics classroom at Ontario colleges. *ResearchGate*. https://www.researchgate.net/publication/321443630

Young, J. R. (2024). The role of technology in enhancing urban mathematics education. *Journal of Urban Mathematics Education, 16*(2), 1-13. https://doi.org/10.21423/jume-v16i2a589

APPENDIX A

Bisection Method

This is an extremely basic way. First, identify two points, $x = a$ and $x = b$, such that $f(a)$ and $f(b)$ have opposite signs. Assume $f(a)$ is negative and $f(b)$ is positive. Then, there will be a root of $f(x) = 0$ somewhere between a and b. Let the first approximation be the midpoint of the interval (a, b), i.e., $x_1 = \frac{a+b}{2}$.

If $f(x_1) = 0$, x_1 is a root; otherwise, the root is between a and x_1 or x_1 and b, depending on whether $f(x_1)$ is positive or negative. Then, we bisect the interval again and repeat the process until the root is located with the requisite accuracy. If $f(x_1)$ is positive, the root is located between a and x_1. The second approximation to the root is given as, $x_2 = \frac{a+x_1}{2}$.

If $f(x_2)$ is negative, then the next approximation is given by $x_3 = \frac{x_2+x_1}{2}$. Similarly, we can get other approximations.

Newton-Raphson Method

This is a powerful numerical equation-solving approach. It is mainly used to approximate the roots of real-valued functions. The successive approximate roots are given by $x_{n+1} = x_n - \frac{f(x_n)}{f'(x_n)}$, $n = 0, 1, 2, \ldots$ Provided that the initial approximate root x_0 is chosen sufficiently close to the root of $f(x) = 0$. The method continues until a suitably exact value is obtained.

Applications

It includes some samples of the transcendental equations we studied and worked on during our research.

Example 1

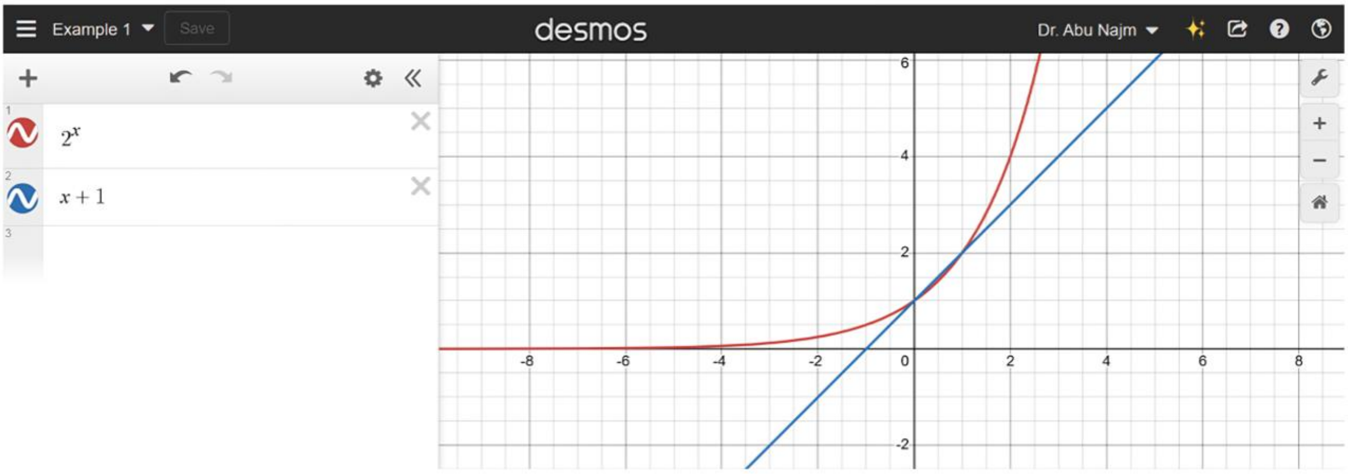
How many root(s) does the equation $2^x - x - 1 = 0$ have? This question will be a threshold point for the students. They can easily find their answers, which are $x = 0$ *and* $x = 1$, approximately.

Solution 1

By using the TEA method.

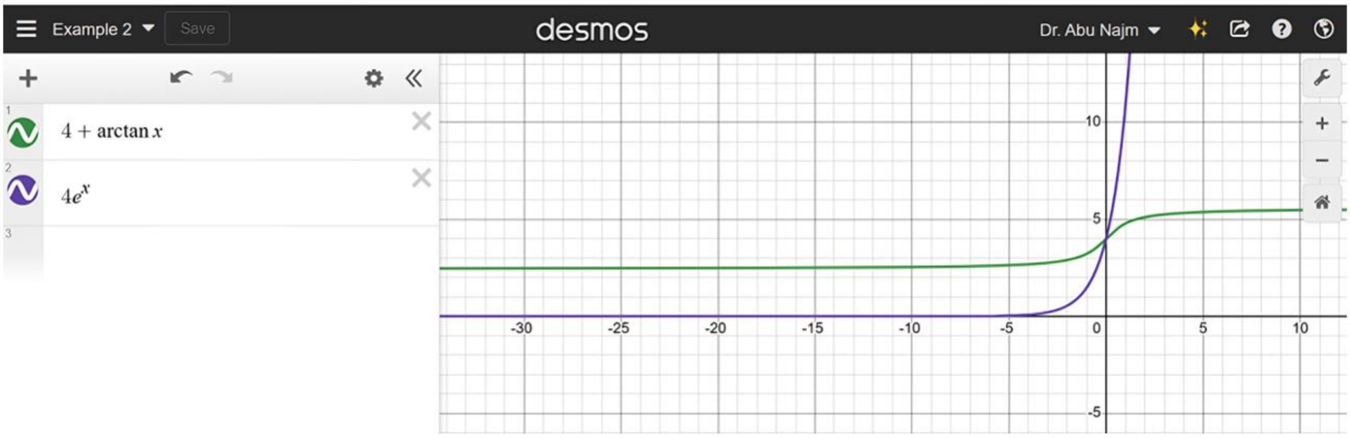
1. **Step 1.** The given transcendental equation can be expressed in the form $f(x) = 0$.
2. **Step 2.** We can separate the left-hand side of the equation as follows: $2^x - (x + 1) = 0$.
3. **Step 3.** Then let us say one part is $\boldsymbol{y = 2^x}$ and the other part is $\boldsymbol{y = x + 1}$.
4. **Step 4.** Let us plot these functions in Desmos with the help of technology.
5. **Step 5.** Let us analyze the graphs and decide about the solution set.

As can be easily seen on the graph, the solution set is written effortlessly in the form of $S = \{0, 1\}$.



Example 2

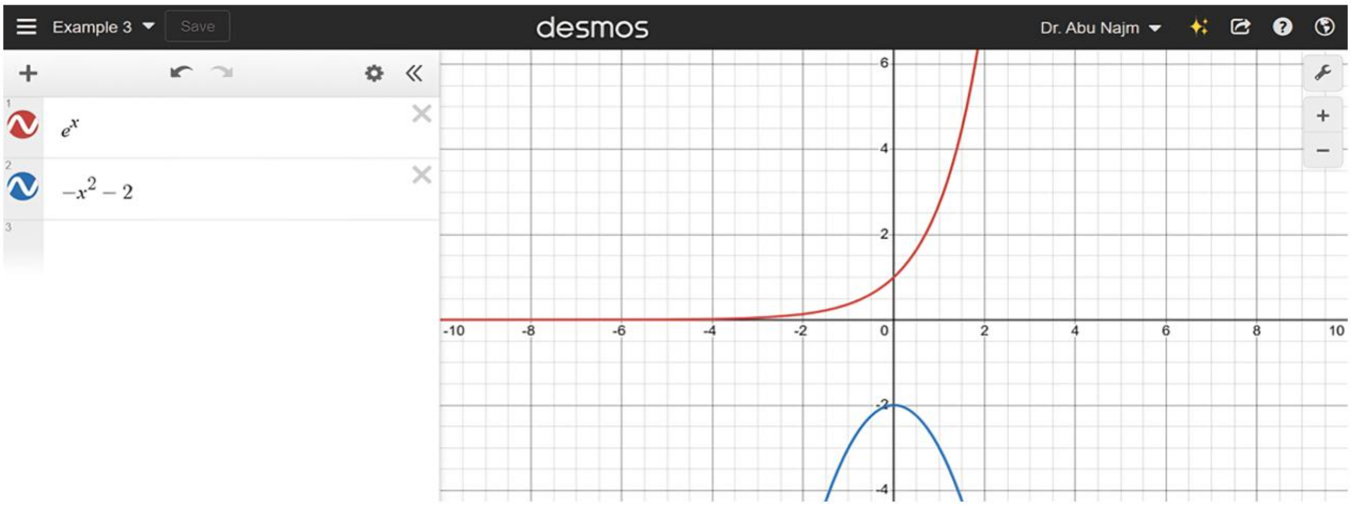
How many root(s) does the equation $4 + arctanx - 4e^x = 0$? $\boldsymbol{y = 4 + arctanx}$ and $\boldsymbol{y = 4e^x}$.



As can be easily seen on the graph, the solution set is written effortlessly in the form of $S = \{0\}$.

Example 3

How many root(s) does the equation $e^x + x^2 + 2 = 0$? $\boldsymbol{y = e^x}$ and $\boldsymbol{y = -x^2 - 2}$.



As can be easily seen on the graph, the solution set is written effortlessly in the form of $S = \emptyset$. When you follow the necessary steps, you will notice that the solution set for examples 4 and 5 is also empty.

Example 4

Solve for $x, e^x - x - sinx = 0$.

Example 5

Solve for $x, e^x - lnx = 0$.

Survey Questions

1. Understanding of concepts: After learning the TEA method, how well do you feel you understand the solutions of transcendental equations using this method? Very well/well/neutral/not well/not at all
2. Ease of application: How easy was applying the TEA method to solve transcendental equation problems? Very easy/easy/neutral/difficult/very difficult
3. Engagement and interest: Did learning transcendental equations with the TEA method increase your interest? Strongly agree/agree/neutral/disagree/strongly disagree
4. Overall preference: Would you prefer to continue learning transcendental equations using the TEA method in future classes? Definitely yes/yes/neutral/no/definitely no