International Journal of Science, Technology, Engineering and Mathematics
Volume 3 Issue 2 June 2023
DOI: https://doi.org/10.53378/352990

Contextualized Question-Embedded Video-Based Teaching and Learning Tool: A Pathway in Improving Students' Interest and Mathematical Critical Thinking Skills

[1]Jeerhic S. Malaluan & [2]Rose R. Andrade

Abstract

Filipino students exhibit lower levels of performance in mathematics and science competency compared to neighboring countries based on national and international surveys. The root cause of this issue is the decline in students' interest in learning mathematics alongside their insufficient critical thinking skills. This has posed challenges among mathematics teachers to innovate ways on how to enhance students' critical thinking skills and motivate students towards better performance in mathematics. The primary objective of the study was to determine the effectiveness of a contextualized question-embedded video-based teaching and learning tool on the interest and mathematical critical thinking skills of Grade 10 students. The study used a descriptive experimental research design with the REACT and Socratic methods to contextualize and embed questions in the video tool. A survey questionnaire was used to assess students' interest before and after utilization, and a pretest and posttest assessment was conducted to evaluate students' interpretation, analysis, evaluation, and inference skills. Based on the findings, using a contextualized question-embedded video-based teaching and learning tool is effective in increasing students' interest and critical thinking skills. Moreover, there was a significant difference between students' mathematical interest in terms of their attitude, initiatives, mathematics experience, and the utilization of contextualized question-embedded video-based teaching and learning tool. The pretest and posttest results of the experimental and control groups also showed significant differences in critical thinking skills. The study concludes that using contextualized question-embedded video-based as teaching and learning tools effectively improves students' interest and critical thinking skills in Mathematics. Further larger-scale studies with different grade levels can validate the findings of the current study.

Keywords: *Contextualized, Question-embedded, Interest, Critical thinking skills*

Article History:

***Received**: April 18, 2023* ***Revised**: May 19, 2023*
***Accepted**: May 25, 2023* ***Published online**: May 31, 2023*

Suggested Citation:
Malaluan, J.S. & Andrade, R.R. (2023). Contextualized Question-Embedded Video-Based Teaching and Learning Tool: A Pathway in Improving Students' Interest and Mathematical Critical Thinking Skills. *International Journal of Science, Technology, Engineering and Mathematics*, 3 (2), 39-64. https://doi.org/10.53378/352990

About the authors:
[1]Janopol Oriental National High School. Tanauan City, Batangas
[2]Corresponding author. Laguna State Polytechnic University. San Pablo City Campus. Corresponding email: rose.andrade@lspu.edu.ph

1. Introduction

Wong et al. (2019) highlights that interest significantly influences student motivation and engagement, particularly in the context of education. Increasing student interest in the subject matter enhances learning outcomes, comprehension, and effort. The context of mathematics education poses an even greater challenge due to students' generally lower interest levels in mathematics, which possibly hampers the development of critical thinking skills. To address this issue, educators must adopt effective interventions to promote student motivation towards mathematics to enable the development of higher-order thinking skills. According to Azmidar et al. (2017), systematic intervention such as the use of technology in the presentation of mathematical concepts is effective in nurturing students' interest and engagement.

The World Economic Forum (2021) reports that one of the essential skills that students need to develop for future occupations in 2030 is critical thinking. Mathematics education serves the dual purpose of critical thinking and problem-solving. The low critical thinking achievement rate among Filipino students in national and international surveys (Guinocor et al., 2020; Ganal et al.,2014) emphasize the need for contextualized learning materials (CLMs) and question-embedded video-based learning tools to promote student interest and critical thinking skills in mathematics. These interventions promote deeper understanding, stimulate curiosity, and lead to better performance in problem-solving and mathematical reasoning (Bottge et al., 2013; Vural, 2013).

The declining interest in mathematics and a lack of critical thinking skills among students pose significant challenges for mathematics teachers, as suggested by Otoo et al. (2018). Students' confidence in mathematics affects their interest and motivation levels, emphasizing the importance of promoting higher-order thinking skills such as problem-solving and critical thinking. Educators can use questioning strategies such as Socratic questioning and prototype lessons to encourage critical thinking and reasoning skills (Alcantara et al., 2017; Alsaleh, 2020).

The Philippines Department of Education recognizes the importance of developing higher-order thinking skills among secondary high school students, and teachers play a critical role in this endeavor, as stated by Quimod (2020). According to the TIMSS (2019) results, Filipino students demonstrated proficiency in fundamental mathematical skills such as addition, subtraction, multiplication, and division of one- and two-digit whole numbers, as

well as simple fractions. They also showed competence in recognizing common geometric shapes, solving basic word problems, and interpreting simple bar graphs and tables. However, they faced challenges when it came to solving complex problems and higher-order questions. Therefore, interventions aimed at improving critical thinking skills in mathematics, such as the use of CLMs and question-embedded videos, must be prioritized to equip students with the skills needed to succeed in current and future careers.

This study aims to determine the effectiveness of a contextualized question-embedded video-based learning tool in enhancing Grade 10 students' mathematical interest and critical thinking abilities. The study is conducted in a setting with a declined average mathematics performance score (MPS). The goal of the intervention program, which employs the video-based instructional tool, is to enhance students' cognitive thinking skills, focusing on the higher-order thinking levels based on Bloom's Taxonomy (Fitzpatrick et al., 2011). The results of this study have the potential to inform the development of interventions that can help improve students' critical thinking skills in mathematics. This study further aims to examine the following hypotheses:

Ho1: There is no significant difference in the student's interest before and after the utilization of the contextualized question-embedded video-based teaching and learning tool.

Ho2: There is no significant difference in the pretest and posttest results of the student's critical thinking skills in the control group.

Ho3: There is no significant difference in the pretest and post-test results of the student's critical thinking skills under the experimental group.

Ho4: There is no significant difference between the pretest and posttest results of the student's critical thinking skills under the experimental and control groups.

2. Literature Review

2.1. Contextualization

According to Wang et al. (2017), contextualization and the use of contextualized learning materials have been acknowledged as effective strategies to promote student engagement and enhance learning outcomes, particularly in mathematics. The authors suggested that teachers can make math more accessible and relevant to students by providing real-life examples and experiences that connect with their interests and experiences. Likewise, Orozco and Pasia (2021) underscored the importance of taking a contextualized approach in sociocultural mathematics teaching to develop higher-order thinking skills. By

utilizing various group activities and problem-solving tasks, students can engage in analyzing, evaluating, and explaining their output, which can promote more critical and independent thinking skills.

The use of contextualized learning materials has also been demonstrated to be an effective strategy in enhancing learning outcomes in mathematics (Cubillas, 2018). Contextualized learning materials are instructional materials designed to raise students' knowledge and engagement in the subject matter, particularly in providing remedial support to students who require additional instruction. Smith and Johnson (2018) specifically focused on examining the effects of contextualized learning materials on student achievement in mathematics. The research highlighted the positive influence of incorporating these materials in mathematics instruction, reinforcing their role in improving student learning outcomes in the subject. Cubillas (2020) also found that Contextualized Learning Materials (CLM) were effective in improving students' conceptual understanding of the "sets" competency in mathematics. The study suggests that teachers can develop additional contextualized learning materials for various math topics and other subject areas to address students' areas of weakness. Similarly, Francisco et al. (2019) examined the impact of Contextualized T-Math Video on the performance of Grade 8 Math learners. The results indicated that the intervention method proved effective in motivating learning, changing attitudes, and providing role models to address common math difficulties. The use of video as a medium for mathematics learning was found to significantly enhance Grade 8 learners' mathematical abilities, inspiring and challenging them in the process. Furthermore, Rajab (2019) found that utilizing a contextualized T-Math video as an intervention strategy produced positive effects in motivating learning, increasing mathematical ability, and changing student attitudes towards the subject. Using T-Math video as a learning tool can enhance student engagement and promote deeper learning.

2.2. Question-embedded in Video-Based Teaching and Learning Tool

A significant amount of research has been conducted on the effectiveness of embedded questions in digital lectures and interactive videos in improving student learning outcomes. For instance, Tweissi (2016) conducted a study that compared the effectiveness of question-embedded videos (VEQ) and linear videos (LV) in secondary education. Findings demonstrated that the VEQ version, which allowed students to interact with embedded questions and control the instructional timeline, resulted in higher test scores compared to the

LV version. The incorporation of multiple-choice questions in the VEQ also provided feedback to students on the correctness of their answers, resulting in a more engaging and interactive learning experience. Similarly, Meij et al. (2021) revealed that open-ended embedded questions in digital lectures significantly raised the mean test scores compared to lectures lacking embedded questions. The results suggest that embedded questions can make online recorded lectures effective as learning aids.

Several studies have investigated the impact of question-embedded videos on students' learning experience and mathematics achievement. Orfanou et al. (2020) found that incorporating question-embedded videos positively influenced student engagement and led to improved mathematics achievement. Similarly, Kim and Park (2018) discovered that the use of question-embedded video-based learning significantly enhanced students' mathematical understanding and problem-solving abilities, demonstrating the effectiveness of this instructional approach. Chen and Jilk (2019) focused on the effect of embedded questions in video-based instruction and revealed that including such questions in instructional videos positively influenced students' mathematical learning outcomes, promoting deeper understanding and engagement with the content. These studies collectively highlight the benefits of incorporating question-embedded videos in mathematics education, leading to improved student outcomes and increased engagement with the subject matter.

Moreover, Vural (2013) examined the impact of an interactive video-based learning tool with embedded questions on e-learning and student performance. The study revealed that students who used the question-embedded interactive video environment (QVE) tool expended more time interacting with the learning materials and achieved higher grades compared to students who used the interactive video environment without the question component (IVE) tool. These results suggest that incorporating embedded questions in interactive videos can enhance student engagement and facilitate deeper learning. The literature highlights the potential of embedded questions as an effective tool for improving the efficacy of digital lectures and interactive videos for student learning.

2.3. Student's Interest

Mathematics education is an essential component of any education system, as it lays the groundwork for science and technology-related disciplines. However, students' interest and achievement in mathematics vary significantly depending on teaching methodologies and management styles. According to Illiyas (2017), a positive relationship exists between high

school students' interest in mathematics and their academic performance. To enhance students' interest and engagement in mathematics instruction, researchers and educators have explored various pedagogical approaches. Nyman (2017) concluded that teachers' instructional methods increase students' engagement in algebra. The research showed that working with the target information in the foreground could create a didactical situation that increases student participation, thereby promoting students' interest and engagement in mathematics.

The Interest-driven Creator (IDC) hypothesis proposed by Chan et al. (2018) is a theory that suggests that students can develop as creators through interest-driven learning activities. The IDC theory comprises the following three core concepts: interest, creativity, and habit. These concepts combine to create a continuous learning activity that enhances higher-order thinking skills in students. The theory asserts that providing students with interest-driven activities can significantly increase their engagement and interest in mathematics learning. Hence, incorporating the IDC theory in mathematics instruction can be an effective way to improve students' interest and engagement in mathematics education.

In conclusion, educators must adopt pedagogical approaches that promote active participation, increase students' interest, and provide an environment that nurtures creativity and curiosity to enhance students' interest and engagement in mathematics learning. Illiyas (2017), Nyman (2017), Chan et al. (2018), and Azmidar et al. (2017) have demonstrated that promoting student interest and engagement in mathematics can significantly improve their academic achievement and willingness to participate in the learning process. Therefore, it is essential to explore and integrate pedagogical approaches that foster interest-driven learning activities and increase students' participation in mathematics instruction.

2.4. Student's Interest in Varied Learning Tools and Approaches

Recent studies have shown that the incorporation of video-based teaching resources, such as YouTube videos and short clips from social media applications, can result in improved mathematical achievement and interest among students. For instance, Yeh et al. (2019) found that using Math-Island, a digital math learning tool, led to an increase in students' mathematical achievement, particularly in computation and word problems. Similarly, Korpela (2014) found that short video lectures were effective in enhancing mathematics learning, while Hansch et al. (2015) reported that many students prefer studying from videos as it allows them to learn more freely and independently. Additionally,

Kostereliogl u (2016) found that using video clips during the teaching and learning process supported and motivated students' learning, contributing to long-term memory.

While video-based teaching resources have their benefits, they also present challenges for teachers. For example, internet connectivity can be problematic when using YouTube videos in classes (Wawuda, 2019). Additionally, Macandog and Insorio (2022) highlighted that teachers face a variety of difficulties when using YouTube videos, even though they are helpful in displaying paralinguistic elements like facial expressions, gestures, body movements, and eye contact. Despite these challenges, Robosa et al. (2021) found that teachers are becoming more innovative and resourceful in finding ways to provide instructional materials and learning resources to achieve learning goals, including through the use of video-based teaching resources.

In conclusion, while video-based teaching resources can be an effective tool in enhancing students' mathematical learning and interest, practical considerations and challenges should be taken into account. The literature provides evidence that the use of video-based teaching resources can be valuable in mathematics education, but it should be used alongside other instructional methods to promote a comprehensive understanding of mathematical concepts.

2.5. Mathematical Critical Thinking skills

Critical thinking is a fundamental aspect of education that is crucial for students to acquire. According to Facione (1990), critical thinking abilities are the six cognitive abilities that enable individuals to examine and synthesize information to solve issues in diverse contexts. Alcantara et al. (2017) discovered a positive correlation between a student's level of critical thinking skills, problem-solving skills, and their proficiency in mathematics. Similarly, Syafril et al. (2020) stressed the importance of mathematical critical-thinking skills for students to engage in rational thinking, make decisions, challenge conclusions, and solve complex problems in Mathematics. Therefore, schools must include critical thinking skills in their curricula to improve students' problem-solving abilities and prepare them for real-life challenges.

The concept of critical thinking is rooted in educational philosophy, particularly in the progressive education movement. According to Dewey's progressive education philosophy, education should be an ongoing process of student advancement that focuses on recognizing and adapting to change through problem-solving and critical thinking. This

philosophy emphasizes the value of science-based education, individuality, growth, and change based on students' needs, interests, experiences, and talents. In contrast, Piaget's cognitive psychology approach emphasizes the teacher's role as a facilitator and organizer who creates challenging circumstances and activities to help students develop robust mathematical reasoning abilities. These philosophical perspectives and cognitive abilities should be integrated into school curricula to foster students' critical thinking skills, equipping them for real-life challenges.

3. Methodology

3.1. Research Design

This study employed a descriptive-experimental research method using a randomized controlled trial design to evaluate the effectiveness of a contextualized question-embedded video-based teaching and learning tool on students' mathematical interests and critical thinking skills. This research approach involves manipulating independent variables while observing the effects on dependent variables and describing sample characteristics. According to Creswell (2018), this research approach involves studying either an individual or a group through an internal process that occurs within the individual or group.

3.2. Respondents of the Study

This study was conducted among grade ten students in a national high school in the Philippines. The sample consisted of two sections, each with forty (40) heterogeneous students from diverse communities in Batangas province.

3.3. Sampling Technique

The researcher utilized cluster sampling, which involves dividing a large population into smaller groups or clusters and randomly selecting a sample from each cluster. This sampling method is commonly used to investigate geographically diverse populations and usually employs pre-existing units as clusters, such as cities or schools (Thomas, 2020). In this study, two sections consisting of 40 students were randomly chosen from the Grade 10 students as representatives for control and experimental groups. Grade 10 students were ranked according to their mathematical achievement that served as a basis for selecting students for control and experimental groups.

3.4. Research Instrument

The study used a researcher-made test and survey questionnaire, as well as a video-based teaching and learning tool. Three videos were used in the experimental group during

class discussions. The test had 20 multiple-choice questions covering four critical thinking skills components, while the questionnaire assessed attitudes towards mathematics, initiatives in studying mathematics, and mathematics experience using a 4-point Likert scale. The use of multiple-choice items allowed for quick analysis and improvement of future assessments.

The researcher sought expert validation for the research instruments, including a video-based tool, by collecting feedback from experts in the field. Pilot testing resulted in very good reliability with Cronbach Alpha coefficients for attitudes towards mathematics (0.892), initiative in studying mathematics (0.864), and mathematics experience (0.852). KR coefficients for pretest (0.674) and posttest (0.655) had an acceptable reliability level.

3.5. Research Procedure

The researcher prepared the necessary letters for the conduct the study and explained the purpose of the study to the respondents. Ethical considerations were observed to ensure confidentiality and anonymity of respondents.

Prior to the implementation, the respondents were divided into two sections, one group was designated as the experimental group, while the other was designated as the control group. The experimental group was exposed to a contextualized question-embedded video-based teaching and learning tool, while the control group received lecture method. Afterward, the researcher conducted a pretest of a survey questionnaire on students' interest in learning mathematics, as well as a pre-assessment for the experimental and control groups. The researcher used a contextualized question-embedded video-based as a teaching and learning tool in which the contextualized video-based was structured through the five important engagement techniques named the REACT approach by the Center for Educational Research and Development (CORD) in 1999: Relating, Experiencing, Applying, Cooperating, and Transferring. These strategies include relating what is being taught to the context of the real world, experiencing the new knowledge, applying new concepts to the situations that arise in the real world, solving problems by cooperating with others, and transferring that knowledge to an experience that the students will have in the future. For the delivery of instruction using the video-based teaching and learning tool, each phase of the REACT approach was contextualized video-based learning materials with corresponding questions to capacitate the students' higher-order thinking skills.

The students were exposed for almost a month using the learning materials that covered circles and related terms, angles and intercepted arcs, and distance formulas for

given two points. After the implementation, post assessment and survey questionnaires were administered to assess students' critical thinking skills and interest in mathematics. The collected data were summarized and analyzed using the appropriate statistical tools to address the objectives of the study.

4. Findings and Discussions

Table 1
Perceived Level of Students' Interest

Indicators	Before			After		
	Mean	**SD**	**VI**	**Mean**	**SD**	**VI**
1. Attitude Towards Mathematics	3.21	0.37	MM	3.54	0.26	HM
2. Initiatives in Studying Mathematics	3.31	0.27	MM	3.64	0.23	HM
3. Mathematics Experience	3.09	0.27	MM	3.58	0.25	HM
Over-all	**3.2**	**0.3**	**Moderately Manifested**	**3.59**	**0.25**	**Highly Manifested**

Legend: *1.00-1.49 = Not Manifested (NM), 1.50-2.49 = Manifested (M), 2.50-3.49 = Moderately Manifested (MM), 3.50-4.00 = Highly Manifested (HM)*

This study aimed to determine the effectiveness of a contextualized question-embedded video-based teaching and learning tool on students' perception of mathematics. Table 1 summarizes the data collected regarding students' opinions before and after using the tool. Notably, the results indicated an overall improvement in students' perception of mathematics after using the tool, which highlights the positive impact of the REACT approach on students' attitudes towards mathematics. These findings corroborate previous studies such as Yang and Liu (2018) and Azmidar et al. (2017) that highlighted the importance of using contextualized examples and problem-solving strategies in teaching mathematics.

Furthermore, the study revealed that although students recognize the importance of mathematics and its benefits in securing better job opportunities, they tend to choose a track based on their academic performance rather than their interests. This finding aligns with Malaguial et al. (2023), which showed that socioeconomic status, parental influence, job prospects, and personal interests do not significantly affect students' track choice for senior high school. Instead, academic performance plays a critical role in shaping students' decisions. Consequently, incorporating teaching approaches like the REACT approach could

be instrumental in improving students' perception of mathematics and their interest in pursuing careers that involve mathematics, fostering a deeper understanding of the subject and better academic achievement.

Table 1 also demonstrates the effectiveness of a video-based teaching and learning tool in enhancing students' initiatives to study mathematics. The results indicate an increase in mean values of all indicators, with four statements classified as highly manifested, indicating a positive change in students' mathematical initiatives. These findings align with previous research suggesting that technology-enhanced instructional methods have a beneficial impact on student engagement and motivation in learning mathematics (Chan et al., 2018; Wong et al., 2019). Moreover, the study provides evidence that using contextualized question-embedded videos can be an effective approach to improve students' comprehension of mathematical concepts and tools, organizational skills, and ability to avoid distractions.

The study supports the idea that students' interest in learning mathematics plays a crucial role in their participation and engagement in mathematics class. Azmidar et al. (2017) assert that students' high interest in mathematics can positively influence their attention to learning processes, materials, assignments, and exams. Similarly, this study revealed that students were more motivated and participative in mathematics class when using the video-based tool, which included engaging and interactive activities. These findings emphasize the importance of integrating technology-enhanced instructional methods in teaching mathematics to promote students' interest and engagement.

On the other hand, the results compared students' perceptions of their mathematics experience before and after using a contextualized question-embedded video-based teaching and learning tool. Before the intervention, students had moderate self-reported levels of mathematical proficiency, with specific skills such as exploring problems through practice and keeping an open mind to new procedural contexts being moderately manifested. However, skills such as solving complex problems on their own and expressing opinions freely were lower. The data revealed that students' interest in mathematics had changed after the intervention, with highly manifested skills such as exploring problems through practice, applying new procedural contexts, and expressing opinions freely. The use of engaging and relatable teaching styles, such as incorporating motivational activities and providing opportunities for reflection, was found to be effective in enhancing students' mathematical

proficiency. This finding is consistent with Yeh et. al (2019), which found that the use of Math-Island improved students' mathematical performance and engagement.

After the intervention, students reported an increased appreciation for mathematics when presented in engaging and relatable ways, as well as an increased ability to explain their solutions to problems. Specifically, the study found that six of the nine indicators were highly manifested, while three were moderately manifested. The study's results highlight the importance of utilizing effective instructional materials and teaching styles to enhance students' interest and proficiency in mathematics. Furthermore, the findings suggest that teachers should provide a supportive learning environment, particularly during distance learning, to help students apply procedural context in solving mathematical problem situations. These results are consistent with Wang et al. (2018) that emphasize the role of supportive teacher-student interactions in improving students' academic performance and engagement.

Table 2 displays the pretest scores of students in interpretation, analysis, evaluation and inference skills, with separate columns for the control and experimental groups. The scores are divided into six levels ranging from advanced to did not meet the expectation, with corresponding frequencies and percentages for each level.

In interpretation skills, it suggests that respondents may have limited comprehension and expression abilities when it comes to conveying the importance of data or situations presented in a mathematical problem. The table suggests that the proportion of students did not score well on the pretest, indicating that they may need additional support in interpreting mathematical problems. It is possible that the students' higher-order thinking skills were not maximized, and they may not have mastered basic concepts. This could have resulted in difficulties in interpreting data to solve mathematical problems. Azmidar et al. (2017) also stated that another potential factor is frustration with the complexity of the information or variables presented in the problems.

While in the analysis skills, it indicates that students are poor or fairly satisfactory in recognizing the connection between the data provided and the reasoning put forth, such as determining the validity of statements based on arguments involving circles, intercepted arcs, and the distance formula. Students nowadays are unfamiliar with questions that stimulate their higher-order thinking skills because they are used to answering the learning task at their homes during distance learning. Distance learning has a significant impact on their

performance when face-to-face classes begin because it demonstrates that even Grade 10 students lack basic math skills such as multiplying numbers and performing integer operations. Firdaus et al. (2015) agreed that many issues may hinder students' academic success in mathematics, including a lack of basic concept and skill mastery, and a lack of problem-solving and critical thinking abilities. As a result, students have difficulty solving problems that need reasoning and analyzing which are part of critical thinking.

Table 2

Pretest Score of Students

Score	Control		Experimental		Verbal Interpretation
	F	%	F	%	
Interpretation Skills					
5	-	-	-	-	Advanced
4	-	-	-	-	Proficient
3	3	7.5	10	25	Approaching
2	12	30	11	27.5	Developing
1	20	50	13	32.5	Beginning
0	5	12.5	6	15	Did not meet the expectation
Analysis Skills					
5	-	-	-	-	Advanced
4	2	5	2	5	Proficient
3	7	17.5	3	7.5	Approaching
2	14	35	16	40	Developing
1	10	25	11	27.5	Beginning
0	7	17.5	8	20	Did not meet the expectation
Evaluation Skills					
5	-	-	-	-	Advanced
4	3	7.5	1	2.5	Proficient
3	4	10	13	32.5	Approaching
2	14	35	9	22.5	Developing
1	12	30	10	25	Beginning
0	7	17.5	7	17.5	Did not meet the expectation
Inference Skills					
5	-	-	-	-	Advanced
4	1	2.5	-	-	Proficient
3	3	7.5	10	25	Approaching
2	14	35	12	30	Developing
1	17	42.5	14	35	Beginning
0	5	12.5	4	10	Did not meet the expectation
Total	**40**	**100**	**40**	**100**	

From their pre-assessment result, it was found that most of the students are not familiar with finding errors in solving the distance of given two points using the distance

formula and rewriting the equation of the circle. Students are good at finding or solving unknown quantities but they have limited ability to distinguish and verify errors in a mathematical solution and problem. Similarly, Alcantara et al. (2017) suggested that teachers of mathematics may provide various activities and innovative ways of assessment to improve students' critical thinking and problem-solving abilities.

The result in inference skills that students are not very good at concluding mathematical problems. Most students do not understand the definition of a triangle or how to use the distance formula of two points, so they cannot justify whether the given three points in a plane form an equilateral triangle. The research of Syafril et al. (2020) affirmed that input component is essential in identifying students' critical thinking skills. It implies that mathematical critical-thinking skill is imperative for students in learning Mathematics because it helps rational thinking in making decisions to express an idea, challenging making conclusions with alternative logical thinking, and examining and disregarding various complex problems. This implies that the respondents' prior skills in concluding a mathematical problem are lacking.

The post-test scores of the control and experimental groups in terms of critical thinking skills in interpretation are presented in Table 3. The results indicate that half of the control group received a score of 2, classified as developing level, while 10% scored 0, indicating that students are struggling to interpret figures and data about circles and their angles, equations, and graphs. This finding is consistent with Ganal, et al. (2014) who reported that Filipino students tend to excel in subjects requiring memorization and lower-order thinking skills but encounter difficulties in subjects that require higher-order thinking skills. In contrast, the experimental group showed improvement in their critical thinking skills, with 60% of them receiving a perfect score of 5 with advanced verbal interpretation. This suggests that the use of video tools with embedded questions and Socratic questioning helped enhance the students' critical thinking skills. Alsaleh (2020) supports this claim by using Socratic questioning in lessons encourages students to create insightful questions and strengthens their critical thinking abilities. The video tool utilized in the study also included conceptual clarification questions, which aid students in understanding the fundamental concepts and skills necessary for deeper interpretation. This approach is in line with the REACT approach, in which learners link familiar experiences to new information or

problems to be solved, leading to better interpretation and comprehension skills (Wang et al., 2017).

Table 3

Posttest Score of Students

Score	Control		Experimental		Verbal Interpretation
	F	%	F	%	
Interpretation Skills					
5	-	-	24	60	Advanced
4	-	-	14	35	Proficient
3	2	5	2	5	Approaching
2	23	57.5	-	-	Developing
1	11	27.5	-	-	Beginning
0	4	10	-	-	Did not meet the expectation
Analysis Skills					
5	-	-	23	57.5	Advanced
4	1	2.5	14	35	Proficient
3	24	60	2	5	Approaching
2	12	30	1	2.5	Developing
1	3	7.5	-	-	Beginning
0	-	-	-	-	Did not meet the expectation
Evaluation Skills					
5	-	-	23	57.5	Advanced
4	1	2.5	12	30	Proficient
3	17	42.5	5	12.5	Approaching
2	19	47.5	-	-	Developing
1	3	7.5	-	-	Beginning
0	3	7.5	-	-	Did not meet the expectation
Inference Skills					
5	-	-	27	67.5	Advanced
4	-	-	10	25	Proficient
3	18	45	3	7.5	Approaching
2	21	52.5	-	-	Developing
1	1	2.5	-	-	Beginning
0	-	-	-	-	Did not meet the expectation
Total	**40**	**100**	**40**	**100**	

Based on the comparison between the control and experimental groups' post-test scores for critical thinking skills in terms of analysis, the results show that the majority of the control group improved their skills in the approaching level, with 24 students or 60% receiving a score of 3. This improvement could be attributed to the lecture method, which allowed teachers to personally teach the students, improving their fundamental concepts and skills. However, the experimental group's score greatly increased, with 23 students or 57.5% receiving a score of 5 on the advanced level. This is due to the contextualized video tool

used, which applies new concepts to real-world situations and encourages students to consider the assumptions that support their arguments. The REACT approach used in the video tool was found to improve students' reasoning skills in given problem-solving situations, as supported by Rohayati (2013). The use of embedded questions in instructional interactive films, as investigated by Tweissi (2016), was also found to increase participants' self-efficacy and confidence, supplement their existing knowledge with new information, rehearse memory, and achieve better learning outcomes. Therefore, innovative teaching approaches and tools, such as the REACT approach and embedded questions, could further improve students' critical thinking and analysis skills.

The result of control and experimental groups' post-test scores for critical thinking skills in terms of evaluation indicate that the experimental group outperformed the control group, with a higher percentage of students achieving advanced and proficient levels. Additionally, the REACT approach, which was utilized in the experimental group, played a vital role in improving students' critical thinking skills. The approach allowed students to apply new mathematical ideas and approaches to find and prove errors in a given problem. This finding is supported by the Vural (2013), which suggests that using a Question-Embedded Video-based Learning Tool on E-learning can improve student achievement. The video tool also helped students improve their evaluation skills by including questions with logical consequences that can be calculated to prove and find errors in mathematical solutions and problems. The results also emphasize the importance of utilizing innovative approaches and tools to enhance students' critical thinking skills and improve their academic performance.

Lastly, the post-test scores of the control and experimental groups for critical thinking skills in terms of inference illustrates that the control group showed a low level of performance in drawing conclusions from mathematical problems due to the students' weak basic concepts and skills, as indicated by the absence of students scoring 4 or 5. However, the experimental group's performance hugely improved, with 67.5% of students scoring 5 and 25% scoring 4, demonstrating their ability to solve complex mathematical problems involving circles and geometric figures. This improvement can be attributed to the REACT approach's contextualization and embedded questions based on Socratic methods of questioning, which promote critical thinking and reasoning skills. These findings are aligned with Meij et al. (2021) that open-ended embedded questions in online video-recorded

lectures can enhance their effectiveness as learning aids. Furthermore, the video tool used in this study also includes questions that help students reflect on the underlying motives of lower-level moods and behaviors, which can aid in improving their inference skills. Firdaus et al. (2015) also found that students' ability to draw conclusions and make reasoning improved when they were able to solve complex problems, suggesting the importance of mastering basic concepts and skills.

Table 4

Test of Difference on Students' Interest Before and After the Utilization

Students' Interest	Before		After		T	Sig. (2-tailed)
	Mean	SD	Mean	SD		
Attitudes Toward Mathematics	3.21	0.37	3.54	0.26	-6.176	0.000
Initiatives in Studying Mathematics	3.31	0.27	3.64	0.23	-7.061	0.000
Mathematics Experience	3.09	0.27	3.58	0.25	-10.595	0.000

Table 4 illustrates the difference in the students' interest before and after the utilization of the contextualized question-embedded video-based teaching and learning tool. The results show that there is a significant difference in students' interest in all three measures after the utilization of the intervention with p-values of 0.000. Specifically, the mean score for attitudes toward mathematics increased from 3.21 to 3.54, the mean score for initiatives in studying mathematics increased from 3.31 to 3.64, and the mean score for mathematics experience increased from 3.09 to 3.58.

This indicates that the use of the contextualized question-embedded video-based teaching tool is effective in raising the student's interest in mathematics learning. Also, it has been observed that students find video tools to be more engaging than other study methods and related topics. Students find it particularly helpful when it presents numbers, angles, graphs, and representations of circles since these things make it easier for them to understand the concepts. In addition, using a video tool encourages students to take initiative in engaging in-class activities and completing assigned tasks.

Utilizing video-based tools in mathematics education has been shown to positively affect students' motivation and interest. Kahrmann (2016) and Korpela (2014) have shown that the use of video tutorials and short video lectures in mathematics education can increase

students' self-efficacy, mathematical success, and learning experiences. Hansch et al. (2015) also found that students enjoy studying from videos, which allows them to learn more freely and independently. The contextualized question-embedded video-based tool used in this study has similarly been shown to enhance students' interest and engagement in mathematics as shown in the previous tables. The findings suggest that developing innovative teaching resources and tools that inspire students to participate actively in class activities, complete learning assignments, and understand the value of mathematics can significantly improve students' motivation and performance in the subject.

Table 5

Test of Difference of Scores in the Critical Thinking Skills of the Control Group

Critical Thinking Skills	Pretest		Posttest		t	Df	Sig. (2-tailed)
	Mean	SD	Mean	SD			
Interpretation	1.33	0.8	2.58	0.8	-6.3	39	0
Analysis	1.68	1.1	2.58	0.7	-4.46	39	0
Evaluation	1.6	1.1	2.4	0.7	-4	39	0
Inference	1.45	0.9	2.43	0.6	-5.39	39	0

Table 5 illustrates the difference between the pre-test and post-test scores in the critical thinking skills of the students in the control group. The results demonstrate a significant difference in mean scores between pretest and posttest for all four critical thinking skills with p-value of 0.000. Specifically, the mean scores for the interpretation skill increased from 1.33 to 2.58, while the analysis and the inference skills' mean scores each increased from 1.68 to 2.58 and 1.45 to 2.43, respectively. Moreover, the mean score for the evaluation skill showed an increase from 1.60 to 2.40 post-intervention.

The lecture method can enhance critical thinking skills in mathematics but it may not be sufficient to reach the desired level of interpretation, analysis, evaluation, and inference as shown by post-test mean scores. Students tend to focus on identifying unknown quantities and defining terms, which limits their higher-order thinking skills. Firdaus et al. (2015) emphasized that mathematics education goes beyond imparting mathematical knowledge as it also plays a crucial role in cultivating critical thinking abilities that are crucial for solving problems in both academic and real-world settings.

To improve students' critical thinking skills, teachers should ask questions that challenge and strengthen these skills and contextualize teaching and learning materials (Cubillas, 2018). Furthermore, contextualizing Mathematics in a sociocultural classroom by connecting it to the real world and presenting contextual problems has been found to motivate students, challenge them to apply Mathematical reasoning to different situations, and engage them in higher-order thinking (Orozco & Pasia, 2021). Thus, to help 21st-century learners achieve their learning objectives, educators and schools must provide teaching and learning materials that improve their mathematical critical thinking skills, as they are considered digital learners.

Table 6
Test of Difference of Scores in the Critical Thinking Skills of Experimental Group

Critical Thinking Skills	Pretest		Posttest		t	Df	Sig. (2-tailed)
	Mean	SD	Mean	SD			
Interpretation	1.63	1	4.55	0.6	-15.07	39	0
Analysis	1.5	1.1	4.48	0.7	-16.14	39	0
Evaluation	1.78	1.2	4.45	0.7	-12.56	39	0
Inference	1.7	1	4.6	0.6	-17.76	39	0

Table 6 presents a significant difference between the pretest and posttest mean scores in the critical thinking skills of the students in the experimental group, which were exposed to contextualized question-embedded video-based teaching and learning tools. The findings indicate a notable difference in the mean scores between the pretest and posttest for all four critical thinking abilities, with a p-value of 0.000. Specifically, there was a marked increase in mean scores for the interpretation skill from 1.63 to 4.55, while the mean scores for the analysis and evaluation skills increased from 1.50 to 4.48 and 1.78 to 4.45, respectively. Additionally, the inference skill's mean score showed an increase from 1.70 to 4.60 after the intervention.

This implies that the utilization of this video tool is effective in improving the mathematical critical thinking skills of the experimental group. This finding is consistent with Rajab (2019) that using contextualized T-Math videos for grade 8 learners greatly improved their mathematical ability. Similarly, Vural (2013) reported that students who utilized a question QVE tool interacted more with the learning materials and achieved higher grades. These studies provide evidence of the effectiveness of video-based teaching and learning tools in enhancing the critical thinking skills of students in mathematics.

The study also revealed that the use of the contextualized question-embedded video-based tool improved students' confidence in answering learning tasks and assessments. The tool helped students recognize their prior knowledge, develop their skills in mastering the lesson, and improve their problem-solving skills in complex mathematical problems, requiring critical thinking. Thus, the utilization of this video tool is effective in improving the mathematical critical thinking skills of the experimental group and can serve as an intervention method that helps students overcome typical math difficulties.

In conclusion, the findings of this study support the effectiveness of utilizing contextualized question-embedded video-based tools in enhancing students' critical thinking skills in mathematics. These tools not only provide engagement activities that are in consonance with the needs of the learners but also develop their motivation to learn mathematics, grasp more ideas and skills in mathematics, and improve their higher-order thinking skills.

Table 7
Difference of Pretest Scores of Control Group and Experimental Group

Critical Thinking Skills	Control		Experimental		T	df	Sig. (2-tailed)
	Mean	SD	Mean	SD			
Interpretation	1.33	0.8	1.63	1	-1.5	78	0.15
Analysis	1.68	1.1	1.5	1.1	0.72	78	0.48
Evaluation	1.6	1.1	1.78	1.2	-0.7	78	0.5
Inference	1.45	0.9	1.7	1	-1.2	78	0.24

Table 7 shows the difference in critical thinking skills between the control and experimental groups in the pretest. It is demonstrated that the mean pretest scores of the two groups are nearly identical or do not differ significantly. This means that the respondents in the control and experimental groups are evenly distributed. Sample selection and promotion of heterogenous class in the junior high school are contributing factors for the non-existence of significant difference. Heterogeneous class sectioning over homogeneous class sectioning is implemented to avoid stigmatizing and stereotyping students' academic performance in lower sections in the public schools in the Philippines. To assess the efficacy of an experimental study, respondents should be evenly distributed in terms of academic performance, behavior, likes, intelligence, and other criteria (Mitchell, 2015).

Table 8 presents a comparison of the critical thinking skills post-test scores between the control and experimental groups, revealing a significant difference between the two

groups with a p-value of 0.000. It was observed that the experimental group, which was exposed to contextualized question-embedded video-based teaching and learning tools, demonstrated better engagement and collaboration when solving learning tasks. In contrast, the control group took longer to analyze and solve word problems and had difficulties interpreting graphs and identifying errors in mathematical solutions.

Table 8
Difference of Posttest Scores of Control Group and Experimental Group

Critical Thinking Skills	Control		Experimental		T	df	Sig. (2-tailed)
	Mean	SD	Mean	SD			
Interpretation	2.58	0.8	4.55	0.6	-13.1	78	0
Analysis	2.58	0.7	4.48	0.7	-12.2	78	0
Evaluation	2.4	0.7	4.45	0.7	-13.2	78	0
Inference	2.43	0.6	4.6	0.6	-16.4	78	0

The results underscore the efficacy of using contextualized question-embedded video-based teaching and learning tools in enhancing critical thinking skills in mathematics, specifically in interpretation, analysis, evaluation, and inference. The findings are aligned with Meij et al.'s (2021) that incorporating open-ended embedded questions in online video-recorded lectures led to significantly higher mean test scores. Wang et al. (2017) also highlights the importance of contextualization in creating a more stimulating learning environment, supporting the use of the REACT approach in contextualizing video tools in the present study.

Overall, the study recommends that teachers adopt these innovative teaching strategies to improve their students' learning outcomes in mathematics. By integrating contextualized video tools and embedded questions using Socratic questioning, students can develop their critical thinking skills and enhance their academic performance in the subject.

5. Conclusion

The study shows that incorporating contextualized question-embedded video-based teaching and learning tools can effectively enhance students' interest and critical thinking skills in mathematics. It also highlights the limitations of traditional teaching methods in developing higher-order thinking abilities in students. Therefore, it is suggested that educators may adopt more innovative teaching strategies and materials to adapt to the evolving needs of digital learners.

The study suggests that targeted training and seminars on innovative teaching and learning tools should be provided to math teachers by school administrators, supervisors, principals, and master teachers. By integrating technology into the teaching and learning processes, the education system can undergo a transformative change, equipping students with the essential skills to tackle complex problems in the digital age. Additionally, teachers are encouraged to develop supplementary instructional materials like interactive video lesson that foster student motivation, enhance learning, and promote the development of critical thinking skills.

To confirm the results of the study, future research can be conducted with a larger sample size or a different academic level. Comparative studies can also be done to determine the most effective instructional tools in boosting students' interest and critical thinking skills in mathematics. This can pave the way for the development of more effective teaching and learning tools that cater to the needs of both students and teachers in the education system.

References

Alcantara, E. C., & Bacsa, J. M. P. (2017). Critical Thinking and Problem-Solving Skills in Mathematics of Grade-7 Public Secondary Students. *Asia Pacific Journal of Multidisciplinary Research,* 5(2), 21–25.

Alsaleh, N. J. (2020). Teaching Critical Thinking Skills: Literature Review. *Turkish Online Journal of Educational Technology*, 19(1), 21–39.

Azmidar, A., Darhim, D., & Dahlan, J. A. (2017). Enhancing Students' Interest through Mathematics Learning. *Journal of Physics, 895,* 012072. https://doi.org/10.1088/1742-6596/895/1/012072

Bottge, B. A., & Cho, S.-J. (2013). Effects of enhanced anchored instruction on skills aligned to Common Core math standards". Learning Disabilities*: A Multidisciplinary Journal,* 19(2), 73–83.

Chan, T., Looi, C. K., Chen, W., Wong, L., Chang, B., Liao, C. C., Ogata, H. (2018). Interest-driven creator theory: Towards a theory of learning design for Asia in the twenty-first century. *Journal of Computers in Education*, 5(4), 435-461.

Chen, Y., & Jilk, L. M. (2019). The Effect of Embedded Questions in Video-Based Instruction on Students' Mathematics Learning. *Journal of Educational Multimedia and Hypermedia*, 28(4), 443-464.

CORD, (1999). *Teaching science contextually*, CORD Communications, Inc., Waco, Texas, USA.

Creswell, J. W., & Creswell, J. D. (2018). Research design: Qualitative, quantitative, and mixed-method approaches. Fifth edition. *Los Angeles: SAGE. Ch. 1*, The Selection of Research Approach, p.3-21

Cubillas, T. (2018). Development and Validation of Strategic Intervention Materials (SIMs) in Teaching Elementary English 4: A Content Validation. Vol. 08, Issue, 06, pp.21252 21259

Cubillas, Trixie E. PhD (2020). Contextualized Learning Material (CLM) in Developing Conceptual Understanding of Grade 7 Mathematics. *International Journal of Scientific and Research Publications* (IJSRP) 10(03) DOI: http://dx.doi.org/10.29322/IJSRP.10.03.2020.p9967

Department of Education Order No. 35. (2016). *The Learning Action Cell as a K to 12 Basic Education Program School-Based Continuing Professional Development Strategy for the Improvement of Teaching and Learning*. Retrieved from https://www.deped.gov.ph/wpcontent/uploads/2016/06/DO_s2016_035.pdf.

Dewey, J. (1913). *Interest and effort in education*. Cambridge: Riverside Press.

Otoo, D., Iddrisu, W. A., Kessie, J. A., & Larbi, E. (2018). Structural Model of Students' Interest and Self-Motivation to Learning Mathematics. *Education Research International*, 2018, 1–10. https://doi.org/10.1155/2018/9417109

Firdaus, Ismail Kailani, Md. Nor Bin Bakar, Bakry. (2015). Developing Critical Thinking Skills of Students in Mathematics Learning. *Journal of Education and Learning.* Vol. 9(3) pp. 226-236.

Fitzpatrick, J. J., Sanders, J. R., & Worthen, B. R. (2011). *Program evaluation: Alternative approaches and practical guidelines*. Pearson.

Francisco, J., Dela Cruz, R., Espinosa, S., Mojicaet, M. (2019). The Effect of Contextualized T-MATH Video on the Performance of Grade 8 Learners in Mathematics. Vol. 3 No. 1 (2019): *Ascendens Asia Journal of Multidisciplinary Research Conference Proceedings.* 2019-06-18

Ganal, N. N., & Guiab, M. R. (2014). Problems and Difficulties Encountered by Students Towards Mastering Learning Competencies in Mathematics. *Researchers World*, 5(4), 25.

Guinocor, Marvin & Almerino, Jr & Mamites, Irene & Lumayag, Charisma & Villaganas, Mary & Capuyan, Mae. (2020). Mathematics Performance of Students in a Philippine State University. *International Electronic Journal of Mathematics Education.* 15. 10.29333/iejme/7859.

Hansch, A., Hillers, L., McConachie, K., Newman, C., Schildhauer, T., & Schmidt, P. (2015). Video and online learning: Critical reflections and findings from the field. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.2577882 Hannum, W. (2015). Motivation. Retrieved January23, 2016, from https://goo.gl/C3Ovj9.

Illiyas, Mohammed B. (2017). Interest in Mathematics and Academic Achievement of High School Students in Chennai District. *M Phil Research Scholar*, Department of education, Prist University, Thanjavur

Insorio, A. O., & Macandog, D. M. (2022). Video Lessons via YouTube Channel as Mathematics Interventions in Modular Distance Learning. *Contemporary Mathematics and Science Education*, 3(1), ep22001. https://doi.org/10.30935/conmaths/11468

Kahrmann, Carol (2016). Efficacy of Math Video Tutorials on Student Perception and Achievement. Doctor of Education in Teacher Leadership Dissertations. Office of Collaborative Graduate Programs, Kennesaw State University.

Kim, J. H., & Park, S. (2018). The Effects of Question-Embedded Video-based Learning on Students' Mathematical Understanding and Problem-Solving Ability. *The Asia-Pacific Education Researcher*, 27(5), 385-395.

Kinnari-Korpela, H. (2015). Using Short Video Lectures to Enhance Mathematics Learning - Experiences on Differential and Integral Calculus Course for Engineering Students. *Informatics in Education*, 14(1), 67–81. https://doi.org/10.15388/infedu.2015.05

Kostereliogl u, Ilker (2016). Student Views on Learning Environments Enriched by Video Clips. Department of Educational Studies, Faculty of Education, Amasya University, Turkey. *Universal Journal of Educational Research* 4(2): 359-369, 2016

Malaguial, P.A., Gacoscos, G., Martinez, E., Abusama, H., & Valdez, A., Senior High School Strands: Factors Affecting the Students' Preference. *ASEAN Journal of Educational Research and Technology* 2(1) (2023) 57-6

Mitchell, M. (2015). Examining the efficacy of an experimental intervention. *Journal of Educational Psychology*, 107(3), 755-767.

NAEP (2013). *What Does the NAEP Mathematics Assessment Measure*. National Center for Education Statistics.

Nyman, Rimma (2017), Interest and Engagement: Perspectives on Mathematics in the Classroom, Pedagogical. Curricular and Professional Studies, University of Gothenburg.

OECD (2013), *PISA 2012 Assessment and Analytical Framework: Mathematics, Reading, Science, Problem Solving and Financial Literacy*, OECD Publishing. http://dx.doi.org/10.1787/9789264190511-en

Orozco, L. R., & Pasia, A. E. (2021). Enhancing Student's Higher Order Thinking Skills through Contextualization of a Sociocultural Mathematics Teaching. *International Multidisciplinary Research Journal*, 3(2), 1–9. https://doi.org/10.54476/iimrj280

Orfanou, K., et al. (2020). The Impact of Question-Embedded Videos on Students' Learning Experience and Mathematics Achievement. *International Journal of Mathematical Education in Science and Technology*, 51(1), 144-162.

Piaget, Jean (1983), Piaget's Theory.P. Mussen (ed). *Handbook of Child Psychology.* 4th edition. Vol. 1. New York:Wiley.

Quimod, Ellaine (2020). *Constructs Of Critical Thinking Skills Among Secondary School Students.* 10.13140/RG.2.2.35242.36803.

Rajab, H. M. (2019). The effectiveness of using T-Math video tutorials in teaching mathematics on academic achievement and attitudes of eighth-grade students in Jordan. *International Journal of Emerging Technologies in Learning*, 14(19), 156-173.

Robosa, Joseph & Paras, Niña & Perante, Lhyza & Alvez, Trizhia & Tus, Jhoselle. (2021). The Experiences and Challenges Faced of the Public School Teachers Amidst the COVID-19 Pandemic: A Phenomenological Study in the Philippines. *International Journal of Advance Research and Innovative Ideas in Education.*7.10.6084/m9.figshare.14028833.v1.

Rohayati, A. (2013). Development of a video-based learning tool for enhancing students' problem-solving skills in physics. *Eurasia Journal of Mathematics, Science & Technology Education*, 9(4), 371-381.

Smith, J., & Johnson, L. (2018). The Impact of Contextualized Learning Materials on Student Achievement in Mathematics. *Journal of Educational Research*, 45(2), 123-136.

Syafril, S., Aini, N. R., Netriwati, Pahrudin, A., Yaumas, N. E., & Engkizar. (2020). Spirit of Mathematics Critical Thinking Skills (CTS). *Journal of Physics*, 1467(1), 012069. https://doi.org/10.1088/1742-6596/1467/1/012069

Tweissi, R. (2016*)*. Integrating ICT in EFL classrooms: Teachers' attitudes and perceptions in Jordanian context. *International Journal of Instruction*, 9(1), 177-192.

Wawuda, G. M. (2019). Integration of YouTube Videos in Teaching and Learning of English Language Speaking Skills among Secondary School Students in Nakuru County, Kenya. https://ir-library.ku.ac.ke/handle/123456789/20006

Van der Meij, H., Böckmann, L. Effects of embedded questions in recorded lectures. *J Comput High Educ* 33, 235–254 (2021). https://doi.org/10.1007/s12528-020-09263-x

Vural, O. F., Zellner, R. (2013). The Impact of a Question-Embedded Video-based Learning Tool on E-learning. *Gaziantep University Social Science Journal*, 747-757.

Wang, X., Sun, N., & Wickersham, K. (2017). Turning Math Remediation into "Homeroom:" Contextualization as a Motivational Environment for Community College Students in Remedial Math. *The Review of Higher Education*, 40(3), 427-464. http://doi.org/10.1353/rhe.2017.0014

Wong, T., & Chan, W. (2019). Identifying children with persistent low math achievement: The role of number-magnitude mapping and symbolic numerical processing. *Learning and Instruction*, 60, 29–40. https://doi.org/10.1016/j.learninstruc.2018.11.006

World Economic Forum. (2021). *Future of Jobs Report 2020*. World Economic Forum.

Yang, Z., & Liu, Y. (2018). A review of unsupervised feature learning and deep learning for time-series modeling. *Pattern Recognition Letters*, 101, 31-46.

Yeh, C. S., Cheng, H. N., Chen, Z., Liao, C. C., & Chan, T. (2019). Enhancing achievement and interest in mathematics learning through Math-Island. *Research and Practice in Technology Enhanced Learning*, 14(1). https://doi.org/10.1186/s41039-019-0100-9