The Digital Technology in the Online High School Mathematics Classroom

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Abstract

The research objectives were to 1) develop a quality digital technology in the online high school mathematics classroom, 2) compare the pre-test and post-test score of students after learning via the digital technology in the online high school mathematics classroom, and 3) study the satisfaction of students who learned via the digital technology in the online high school mathematics classroom. The samples of this study were 20 students in high school mathematics class who selected from students registered for the subject mathematics. The instruments consisted of digital technology, an evaluation form regarding the quality of media and contents, the pre-test and post-test assessment form, and an evaluation form regarding student's satisfaction towards the digital technology. Statistics used for data analysis were mean, standard deviation, and t-test for dependent samples. The results showed that 1) the digital technology achieved in media at an excellent level with the average score of 4.57 and quality of contents at an excellent level with the average score 4.93; 2) the students who learned via digital technology had an average the pre-test score of 64.75 points and post-test scores 79.70 points, respectively, when comparing the pre-test and post-test scores, so that the post-test scores were higher than pre-test scores with statistical significance at the level. 05; and 3) the students were satisfied with digital technology overall the students' satisfaction was found to be at a high level with the average score of 4.44.

Keywords: Digital Technology, Online Classroom, High School Mathematics

Introduction

In today's knowledge economy era, mathematics is moving from behind the scenes to the forefront. The combination of mathematics and computer technology has directly created value for society in many aspects and promoted the development of social productivity (Annie, Stoker, & Murray-Ward, 1996). Mathematics is an important component of human culture and has become a fundamental quality that citizens must possess. Mathematics plays a unique and irreplaceable role in the formation of human rational

thinking (Smith & Jones, 2000). Since the new curriculum reform, various aspects of high school mathematics teaching have undergone significant changes, but there are still some problems in many aspects. As an important discipline for measuring a person's abilities, many excellent elementary and middle school mathematics students will encounter difficulties in mathematics when entering high school, gradually evolving into a fear of high school mathematics (Brown, 2015). This phenomenon is quite common and should be taken seriously. Countermeasures for this phenomenon. The main manifestations are:

1. Many students have not mastered the learning initiative after entering high school. If you don't decide, you sit and wait for class. There is no preview before class. You don't understand what the teacher is going to teach. You are busy taking notes in class and don't really understand what you have learned.

2. In class, teachers should generally explain the context of knowledge, analyze the connotation of concepts, analyze key and difficult points, and highlight the way of thinking. After class, they couldn't consolidate, summarize, and find the connection between knowledge points in time. They just rushed to do homework, randomly set up questions, knew only a little about concepts, rules, formulas, and theorems, mechanically imitated them, and memorized them by rote.

3. Some students who feel good about themselves often belittle the learning and training of basic skills and methods. They often know how to do it, but don't pay attention to the calculation and writing. It is easy to have high vision and low skill. When they arrive at the regular homework or exam, either they make mistakes in the calculation, or they get stuck halfway.

4. Compared with junior high school mathematics, senior high school mathematics is a leap in depth, breadth and ability of knowledge. This requires mastering basic knowledge and skills to prepare for further study. There are many places in high school mathematics with great difficulty, new methods and high requirements for analytical ability. For example, the maximum problem of quadratic function on closed interval, real root distribution and parametric equation, the deformation and flexible application of trigonometric formula, the formation of spatial concept, permutation and combination problems and practical application problems. Therefore, these foundations must be well prepared for your next step of learning.

5. Teachers only pay attention to teaching, students can only passively receive relevant information, and the flow of information is unidirectional. The central activity of the whole class is "teaching" rather than "learning". Teachers are the theme of the class, and students are just the objects of classroom teaching. This unipolar tendency tends to make students become receivers of knowledge, but they have little opportunity to question and think, and ultimately their understanding of knowledge is superficial.

6. The effect of individualized teaching is poor. Through the survey, it is found that the current teaching plan of high school mathematics teachers focuses on the teaching content, such as teaching focus, teaching difficulties, teaching objectives, etc. Teachers should take these different needs of students into consideration and make corresponding adjustments in the arrangement of teaching content and the choice of teaching strategies. However, it is a pity that the current high school mathematics teachers generally do not make efforts in this regard. In the actual teaching process, they often teach courses at the same level as all students.

7. Effective teaching should be the teaching in which students actively participate and easily achieve the teaching objectives. Specifically, an effective teaching classroom should have the following three characteristics: first, students get cognitive development in teaching, second, students' subjective initiative can be fully mobilized in teaching, and finally, students can creatively apply the knowledge they have learned. But now the high school mathematics teaching is generally centered on teaching.

Under the background of the new curriculum reform, these problems in senior high school mathematics teaching should attract educators' extensive attention. All high school mathematics teachers should take active action to change teaching centered into learning centered, highlight students' dominant position, stimulate students' motivation for independent learning, play their leading role, and effectively improve the effectiveness of high school mathematics teaching.

Objectives

1. To develop quality digital technology in the online High School Mathematics classroom.
2. To compare the pre-test and post-test score of students after learning via digital technology in the Online High School Mathematics Classroom.
3. To study the satisfaction of students who learned via digital technology in the Online High School Mathematics Classroom.

Literature, Theories

Digital Technology

When computers first appeared in school mathematics classes in the 1970s the emphasis was, rightly, on how they might be used to improve student learning. In more recent years there has been a subtle shift of emphasis on how to improve learning. This has been informed by research, such as the statistical meta-analysis of Hattie (2003), which has found clear evidence that of all the factors influencing student activity it is the teacher who most influences learning. This has been recognized by others, such as Kieran, Krainer

and Shaughnessy (2013) who stated, “it is the teacher who can affect to the greatest extent the achievement of one of the main purposes of the research enterprise, that is, the improvement of students’ learning of mathematics”. In addition, in the last two decades the range of digital technology available has expanded considerably and their facilities and power have also greatly increased. In the light of these changes, the research focus of many has moved from how computers can help with learning to how teachers can make practical use of different types of digital technology to provide students with activities that will enhance their mathematical learning (Clark-Wilson, Robutti, & Thomas, 2020). The digital technology is an application which is named DingTalk. DingTalk is an enterprise communication and collaboration platform developed by Alibaba Group. It was founded in 2014 and headquartered in Hangzhou. By 2018, it was one of the world's largest professional communication and management mobile apps in China with over 100 million users. International market intentions were announced in 2018.DingTalk provides iOS and Android apps as well as Mac and PC clients.

Online Teaching

Online learning has been on the increase in the last two decades. In the United States, though higher education enrollment has declined, online learning enrollment in public institutions has continued to increase and so has the research on online learning. There have been review studies conducted on specific areas on online learning such as innovations in online learning strategies, , quality in online education, , accessibility in online higher education, synchronous online learning, meaningful learning research in e-learning and online learning environments, problem-based learning in e-learning and online learning environments, self-regulated learning in online learning environments and , game-based learning in online learning environments. (Martin, Sun, and Westine, 2020).

Online teaching is to take advantage of the network platform as the carrier of teachers' teaching and students' learning, transcend space constraints, and carry out bilateral teaching activities. With the upgrading of communication technology, teaching activities are accurately monitored and recorded. During the teaching process, the learning content is presented in the form of multimedia. The teaching activities are carried out on the network, and the learning track is presented on the network. Students realize the teaching purpose and plan through online learning and communication. Compared with traditional teaching, online teaching has the characteristics of more flexibility, repetition, small number of restrictions, and higher requirements for learners' self-consciousness. At present, online teaching mainly includes live teaching and recorded teaching. Live teaching has the advantage of timely interaction and adjustment, while recorded teaching has the advantage of free learning time.

Duval's Geometric Cognitive Theory

Geometric cognitive theory posits those solid figures aid in the acquisition of abstract knowledge in geometry learning (Duval, 1995). Raymond Duval, a prominent French mathematics education scholar, introduced four concepts of cognitive understanding in 1995: perceptual understanding, sequential understanding, discursive understanding, and operational understanding (Duval, 1995).

Perceptual understanding involves the perception of a figure's appearance (shape, size, etc.), allowing for the distinction of subgraphs, although these may not fully align with the original figure. Sequential understanding refers to the presentation of different unit components of a figure in a specific order during the composition process. Discursive understanding emphasizes that geometric concepts should stem from the naming and hypothesizing about figures, and the identification of geometric properties should be based on discussion. Operational understanding enables students to derive solution ideas by manipulating the figure while observing it (Duval, 1995).

Duval's theory focuses on the understanding process of geometric problems, particularly in presenting geometric figures for geometric reasoning and proof, providing a theoretical basis for solving geometric problems (Duval, 1995).

Mathematics

The online classroom teaching content mainly focuses on learning the knowledge points related to the chapter of "line plane parallelism" in solid geometry and training classroom exercises. The knowledge points mainly include the recognition of the spatial position of line plane parallelism, the determination and property theorems of line plane parallelism (Smith, 2021). Then, through various classroom training, students can fully understand the methods and skills of using judgment and property theorems (Jones & Brown, 2020). In this process, the stimulation and exercise of spatial imagination ability is particularly important (Johnson, 2019). Taking the judgment of parallel lines and planes as an example, in the teaching stage of new courses, it is necessary to first set teaching objectives, such as knowledge points and key and difficult points, processes and methods, emotional attitudes and values, etc. (Clark, 2018). In online classrooms, educational media is also very important, especially in the chapter on solid geometry, which is crucial for cultivating students' spatial imagination ability (Miller, 2017). In the online classroom, CAD modeling software has been introduced, which can directly generate very intuitive and visible spatial three-dimensional structures, helping students understand various spatial positional relationships (Garcia, 2019). Of course, the setting of teaching methods is also crucial. Throughout the process, students can use the online classroom platform to listen to classes and receive after-school assignments from teachers, in order to consolidate and

strengthen their understanding and application of knowledge points through practice after class (Robinson, 2020).

Academic achievement

Study.com (2022) mentions that academic achievement or academic performance is the extent to which a student, teacher or institution has attained their short or long-term educational goals. Completion of educational benchmarks such as secondary school diplomas and bachelor's degrees represent academic achievement.

Annie, Stoker and Murray-Ward (1996) give meaning of Academic achievement is commonly measured through examinations or continuous assessments but there is no general agreement on how it is best evaluated, or which aspects are most important—procedural knowledge such as skills or declarative knowledge such as facts.

In addition, Ziedner & Mosche (1998) further note that there are inconclusive results over which individual factors successfully predict academic performance, elements such as test anxiety, environment, motivation, and emotions require consideration when developing models of school achievement.

Student Satisfaction

Satisfaction according to Giese and Cote (2000) comprises of three crucial elements which are first, a general affective response that varies in its intensity, secondly a focus on the choice of product, purchase or consumption and lastly, the moment of determination that varies according to different situations and duration in time. The term satisfaction itself creates a vast diversity within industry and societal perspectives and varies with regard to the object focus and level of specificity.

Harvey, Plimmer, Moon, and Geall (1997) also indicate that student satisfaction is a quality enhancement tool which is designed to improve the quality of student experience. In addition, Bailey, Bauman and Lata (1998) study shows that student satisfaction can be viewed in a way of associating various multiple factors such as campus community, advertising services, and faculty in the educational environment accounted for the variance in students' satisfaction.

Concept Framework

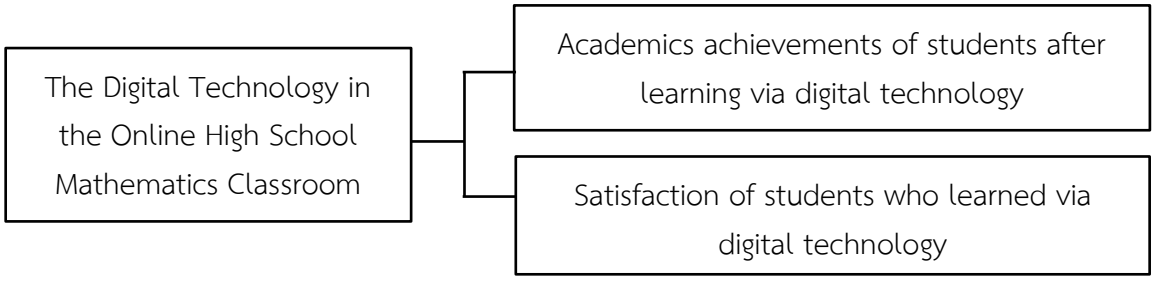

Figure 1: Concept Framework

Research Questions and Hypothesis

Students who study via digital technology in the Online High School Mathematics classroom can increase their academic achievement.

Research Methodology

Population Scope and Sample

1. The population of this study is 70 students at Shunde No.1 Middle School.

2. The sample of this study was 20 students at Shunde No.1 Middle School. They were selected by using purposive sampling who selected from students registered for the subject mathematics.

Research Instruments

The instruments consisted of

1. The digital technology

The digital technology is an application which is named DingTalk. DingTalk is an enterprise-level intelligent mobile office platform created by Alibaba Group. It will lead a new generation of working methods in the future and will accompany the growth of every enterprise. It is a collaborative office and application development platform for enterprise organizations in the digital economy era and a new productivity tool. The following sentences are the steps to use Dingtalk for an online class:

Figure 1: Home page of Dingtalk program

Step 1. Preparation for live broadcast

Step 2. Initiate a group live broadcast

Step 3. After-class work

2. An evaluation form regarding the quality of media and contents

Create an Evaluation form regarding the quality both content and media were on a 5-level scale and taken to 3 measurement and evaluation experts to check the suitability and consistency of content with objectives and obtain an index of item objective congruence of content of 1.00 and media of 1.00.

3. The pre-test and post-test assessment form

Create the pre-test and post-test assessment form and go to a team of 3 evaluation experts to check the appropriateness and consistency of the content and objectives. The index of item objective congruence of content was 1.00 and take the pre-test and post-test assessment form to let's check the score to find the difficulty value (p) and the discriminatory power value (r) for each item. The pre-test and post-test assessment form has a difficulty value between 0.50-0.63 and a discriminatory power value between 0.25-0.50 and is taken to find Reliability using the formula. Finding the Reliability value of the test using the KR-20 method (Kuder Richardson Formular 20) obtained a Reliability value of 0.94.

3. An evaluation form regarding student's satisfaction towards the Digital Technology

Create An evaluation form regarding student's satisfaction towards the Digital Technology. It is a 5 - level rating scale questionnaire, and the created satisfaction questionnaire was given to 3 evaluation measurement experts to consider and check its suitability, and the consistency of the questions with each objective with an index of item objective congruence value of 1.00.

Results

The results of the experiment by following the structure below.

1. Results of evaluating the quality of digital technology in the online High School Mathematics classroom.

1.1 The digital technology quality assessment results from three media experts as shown in Table 1.

Table 1: The digital technology quality assessment results from three media expert

Option	$\bar{X}$	SD.	Meaning
1. Easy of use of the system.	4.67	0.22	Excellent
2. The order in which information is displayed is appropriate.	4.67	0.22	Excellent
3. Easy and convenient access.	4.67	0.22	Excellent
4. The overall screen design is appropriate.	4.67	0.22	Excellent
5. Presentation control buttons are appropriate.	4.67	0.22	Excellent
6. The font style is easy to read and clear.	4.67	0.22	Excellent
7. The font size is appropriate.	4.67	0.22	Excellent

8. Interesting, inviting you to follow the content.	4.00	0.67	Good
9. Choosing the color of the font and background color	4.67	0.22	Excellent
10. The lessons are interesting.	4.33	0.22	Good
Total	**4.57**	**0.27**	**Excellent**

Form table 1 presented the results of the digital technology in the online High School Mathematics classroom. Overall, it was found that the quality of the digital technology is at an excellent level with the average score of 4.57.

1.2 Content quality assessment results from three content experts as shown in Table 2

Table 2: The content quality assessment results from three content experts

Option	$\bar{X}$	SD.	Meaning
1. The content is easy to read and understand.	5.00	0.00	Excellent
2. The amount of content is appropriate.	4.67	0.22	Excellent
3. The difficulty of the content is appropriate to the student's level.	4.33	0.22	Good
4. The test is appropriate.	4.33	0.22	Good
5. Assessment and evaluation are appropriate.	5.00	0.00	Excellent
6. The font style is easy to read and clear.	5.00	0.00	Excellent
7. The font size is appropriate.	5.00	0.00	Excellent
8. Provide content knowledge just like the teacher.	5.00	0.00	Excellent
9. The sequence of steps in the presentation is appropriate.	5.00	0.00	Excellent
10. Accuracy of the language used.	5.00	0.00	Excellent
Total	**4.93**	**0.07**	**Excellent**

From table 2 presents the results of content quality assessments, overall, it was found that the quality of the digital technology is at an excellent level with the average score of 4.93.

2. Results of compare the pre-test and post-test scores of students after learning via the digital technology in the Online High School Mathematics Classroom.

Table 3: Compare the pre-test and post-test score of students after learning via the digital technology of students

Items	n	$\bar{X}$	SD.	t-test	Sig. (2-tailed)
Pre-test	20	64.75	11.63	6.67	.000
Post-test	20	79.70	12.26		

**p< .05

From table 3 the results of the pre-test and post-test tests of the students had an average score of 64.75 points and 79.70 points, respectively. When comparing the pre-test and post-test scores, it was found that the post-test scores were higher than pre-test scores, with statistical significance at the level. 05

3. Results of study the satisfaction of students who learned via the digital technology in the Online High School Mathematics classroom.

Table 4: The satisfaction of students who learned via the digital technology in the online High School Mathematic Classroom.

Option	$\bar{X}$	SD.	Meaning
1. Easy to use, not complicated	4.54	0.71	Highest
2. There is appropriate positioning of various information on the screen.	4.39	0.86	High
3. Easy and convenient access	4.46	0.81	High
4. The test is appropriate.	4.43	0.70	High
5. Presentation control buttons are appropriate.	4.49	0.74	High
6. The font style is easy to read and clear.	4.50	0.81	Highest
7. The font size is appropriate.	4.49	0.69	High
8. Choosing the color of the font and background color	4.48	0.71	High
9. The difficulty of the content is appropriate to the student's level.	4.46	0.81	High
10. The lessons are interesting.	4.12	1.30	High
Total	**4.44**	**0.81**	**High**

From table 4 presents the results of study the satisfaction who studied in the online High School Mathematic Classroom, overall, it was found that the quality of the students' satisfaction is at a high level with the average score of 4.44.

Conclusions and Discussion

The research conclusions can be discussed as follows.

1. The Results of evaluating the quality of digital technology in the online High School Mathematics classroom; the digital technology quality assessment results from three media experts were at an excellent level with the average score of 4.57. Different from the research of She Haiyan (2020) the application research of schivo whiteboard in high school mathematics teaching. n the application research of schivo whiteboard in high school mathematics teaching, the author collects media usage and usage feedback in the same form in the form of a questionnaire survey. However, the author's questionnaire is

set in the form of multiple-choice questions for the questions in the questionnaire, and the author will calculate the selection proportion of each option in the questionnaire, mainly through the selection proportion to reflect what the author of each type of question wants to know. Regarding the use of media. The author will also conduct a reasonable analysis based on the proportion of each option in each question collected and collect media usage and usage feedback in the form of a questionnaire survey, but the difference is that each question in the questionnaire adopts a scoring mechanism of 1 to 5 points, and each score has its own separate meaning. There will be explanations at the beginning of the questionnaire. What this kind of questionnaire collects is the score of each function of the media. There are very direct numerical results that can directly reflect the quality of each function of the media, and the author will also make corresponding result analysis based on the score of each question. The results of content quality assessments overall, it was found that the quality of the digital technology is at an excellent level with the average score of 4.93. Different from Shao Zhen (2021) the research of teaching research on"six questions and mind map" in senior high school mathematics. In teaching research on "six questions and mind map" in senior high school mathematics, the author uses the method of showing instructional design cases as an example, here using exponential functions and their properties. The content mainly includes:

1.1 Teaching materials and academic situation analysis.

1.2 Teaching objectives: knowledge and skills, processes and methods, emotions, attitudes and values.

1.3 Analysis of key points and difficulties.

1.4 Teaching methods: combination of lecture and practice, cooperative learning, inquiry teaching.

1.5 The teaching process, including a rough process design for the entire lesson, and marking the design intent where necessary. This part is the most meticulous part in the entire teaching design. The role of each step, time-consuming and other factors must be taken into consideration.

1.6 If media application is involved in class, it must also be noted.

2. Results of compare the pre-test and post-test scores of students after learning via the digital technology in the online High School Mathematics classroom.

The results of the pretest and post-test tests of the students had an average score of 64.75 points and 79.70 points, respectively. When comparing the pretest and post-test scores, it was found that the post-test scores were higher than pretest scores, with statistical significance at the level. 05. Consistent with the research of Qiao Rui (2021) the application of geometer's sketchpad in mathematics teaching in high school and She

Haiyan (2020) the application research of Schiavo whiteboard in high school mathematics teaching. For example, in the application research of Schiavo whiteboard in high school mathematics teaching, the author used the method of controlled experiment to study the students in Class 10 and Class 11 of a high school in Hefei Economic Development Zone. Both classes had 47 students. Class 11 was an experimental class and class 10 is a control class. Both classes are ordinary classes. They are evenly divided according to their high school entrance examination scores. There is not much difference in the average math scores in the school entrance examination. To ensure the reliability of the experiment, both classes used the People's Education Press version of high school mathematics textbooks. They had the same mathematics teachers, the same homework, teaching content and teaching progress. Students were not told any relevant information about the experiment before the experiment, thereby improving the efficiency of the experimental validity and reliability.

This comparison method uses a pretest and post-test there are some differences in details, the overall core idea is to explore the effect of a single variable on another variable while ensuring that other factors are not affected as much as possible, also conducted t-test and sig significance tests on the two sets of experimental data, which is also of high reference value for determining the use value of the data.

3. The Results of study the satisfaction of students who learned via the digital technology in the online High School Mathematics classroom were overall satisfied via digital technology overall; it was found that the quality of the students' satisfaction is at a high level with the average score of 4.44. Different from the research of Qiao Rui (2021) the application of geometer's sketchpad in mathematics teaching in high school.

In the application of geometer's sketchpad in mathematics teaching in high school by the collection of student satisfaction in the form of a questionnaire survey. However, the author's questionnaire is set in the form of multiple-choice questions for the questions in the questionnaire, and the author will calculate the selection ratio of each option in the questionnaire, mainly through the selection ratio to reflect what the author wants to know for each type of question. Regarding student satisfaction and other student attitudes. The author will also conduct a reasonable analysis based on the proportion of each option in each question collected. Based on this result, the author analyzed that most teachers do not pay enough attention to class speed when teaching using geometric sketchpads, ignore the difference between online teaching and offline teaching, and basically display knowledge entirely through software, replacing traditional writing on the blackboard. This seriously leads to students' note-taking efficiency being reduced and their knowledge mastery not being proficient. The geometric sketchpad is only an indispensable electronic technology in teaching. The purpose is to better improve learning efficiency,

not to replace writing on the blackboard with media. The geometric sketchpad should be appropriately introduced in the teaching process, rather than relying entirely on this media.

The method of collecting student satisfaction is in the form of a questionnaire survey, but the difference is that each question in the questionnaire uses a scoring mechanism of 1 to 5 points. Each score has its separate meaning. This is stated at the beginning of the questionnaire. There will be explanations. What this kind of questionnaire collects is the score of each function of the media. There are very direct numerical results that can directly reflect the quality of each function of the media, and the author will also make corresponding result analysis based on the score of each question.

Recommendations

Significant recommendations or research findings useful for mathematics teachers:

1. Utilization of digital technology in teaching mathematics: Teachers can utilize various applications and computer programs to enhance students' learning experiences in the classroom. Emphasis should be placed on making learning more engaging and effective.
2. Use of data and data analysis: Teachers can use data obtained from digital technology usage in teaching to improve their teaching methods. This data can be used to adjust lesson plans and respond to students' needs effectively.
3. Creation and sharing of learning content: Teachers can use digital technology to create engaging and effective learning content. They can also share this content with other teachers to serve as references and share best teaching practices within the mathematics teaching community.
4. Enhancement of technology skills for teachers: Teachers should receive training and support in using digital technology for teaching. Focus should be on developing skills and fostering creativity in using these technologies for teaching mathematics in the classroom.

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