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PAPER

Effects of Multimedia Video Integrated STEM Curricula on Learning Attitude and Learning Achievement

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ABSTRACT

Along with the advance of 3C technology and the promotion of education reform, multimedia video information equipment is largely combined in the education scene for student-centered course teaching. Including multimedia video in instruction for curriculum design provides students with diverse teaching and learning methods. It is expected to enhance students' learning attitudes and achievements through vivid and active multimedia video situations, as well as guide students' interests and achievements in learning. Taking 188 college students in Guangdong Province as the experimental objects, the 16-week (3 hours per week for a total of 48 hours) multimedia video integrated science, technology, engineering, and mathematics (STEM) experimental teaching research is preceded by this study. The research results show that: (1) students present a positive learning attitude as they expect to understand more of the taught content from multimedia video-integrated STEM curricula; (2) multimedia video-integrated STEM curricula provide students with effective learning; and (3) the use of multimedia video provides more opportunities and information for students to understand STEM-related information. The assistance of multimedia video could enhance their willingness to learn and creativity in STEM curricula. According to the results of proposed discussions and suggestions, it is expected to provide students with diverse learning methods and build students' learning concepts without restricting learning to time and place.

KEYWORDS

multimedia video, science, technology, engineering, and mathematics (STEM), learning attitude, learning achievement, learning gain

1 INTRODUCTION

Technology is bringing reform to education and other aspects of life. Traditional teaching styles are no longer favored by students; especially in science, teachers have to constantly update information or apply multimedia to enrich teaching content and connect to technology development in the world. Information technology is therefore definitely required as the spirit of many courses in different learning areas

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to expand the learning and cultivate basic competence for modern citizens with life experience as the key point. Including information in course teaching activities is essential in modern teaching sites as well as one of teachers' teaching abilities. In modern teaching sites, Power Point (PPT) presentations, Internet information, e-books, electronic whiteboards, and uploading assignments to the cloud have become the best resources to assist teachers' teaching. It does not simply change the past teaching model but could also enhance students' learning achievement, make teaching sites lively, and allow students' creative works or designs to combine with real life. In sum, education directs life-centered instruction rather than textbooks delivered with single texts. Guiding students' learning through technological information is the key issue for teachers' discussions and thinking. Since the USA promotes science, technology, engineering, and mathematics (STEM) education, other countries such as Britain, Germany, and the Mainland China will also announce relevant regulations and policies as well as invest in the budget for the promotion. It therefore becomes a global educational trend.

The key to technology education lies in the course content, which integrates computational thinking, social technology, mathematics, natural technology, and art in various areas for students to solve life's issues in various situations. STEM education emphasizes the spirit of interdisciplinary integration and is divided into six fields: body movement and health, cognition, language, society, emotion, and aesthetic perception. The abilities in the fields are connected and preceded simultaneously among fields, based on interdisciplinary integration, to support students' comprehensive development and learning in the social-cultural activity participation process. The curriculum mapping takes care of students' unique needs at different stages and concerns about the connection among learning stages. Teachers' professional teaching abilities are the key to opening students' diverse learning interests, and the major teaching responsibility also bears the expectations of parents and society [1]. In this case, integrated planning and design of courses in different fields are the professional abilities of teachers. Teachers are the helmsmen to implement professional preschool education; both indoor teaching and outdoor activity reveal their influence on students' future learning [2]. The effect of multimedia video-integrated STEM curricula on learning attitude and learning achievement is therefore discussed in this study, which expects to provide diverse learning methods for students. More importantly, learning is not restricted to schools; students can learn at home as well as watch and learn through computers, mobile phones, and tablet computers at anytime and anywhere to build the learning concept.

2 LITERATURE REVIEW

The development of multimedia technology in the past few years has been gradually applied to lessons. The pictures and texts, sound and light effects, dynamic and static combinations, and interactive and communication elements largely enhance people's perception and comprehension of abstract affairs and process them into the brand-new realm [3]. Multimedia instruction should cover multimedia instruction tools and application software. Multimedia instruction application software is designed according to instructional objectives to present specific teaching content and inspire students' learning. It could be used for storing, delivering, and integrating teaching messages for students' operation, practice, exchange, and interaction, as well as evaluating students' learning outcomes [4]. Li et al. [5] explained the characteristics of multimedia instruction as follows:

1. Vivid content and novel style to induce learning interests: Multimedia instruction, covering information in texts, pictures, sound, and images, provides students with visual and audial stimulation so that dull language teaching becomes vivid and abstract concepts are easily comprehended to largely enhance students' learning motivation and interests.
2. Rich content and open vision to enhance teaching efficiency: Teachers, according to syllabus and content, could collect large teaching materials through Internet information or platforms to highlight the points and difficulties, as well as make explanations and demonstrations with vivid examples to promote students' comprehension and application of teaching content. It also largely promotes teaching quality and efficiency.
3. Repeated learning and interactive learning without being restricted to areas: Multimedia instruction provides rich pictures and texts and an easy-to-operate human-computer interaction environment. Students could select learning content according to their personal basis and rhythm, as well as utilize networks or open platforms for sharing and communicating with classmates and teachers, to fully develop the objectives of self-directed learning, repeated practice, and communication improvement. The popularity of network and multimedia tools allows students to engage in effective learning during movement, after class, at home, or outdoors. With multimedia instruction, schools and teachers are no longer the sole learning route. When learning is not restricted to sites, the door for learning will be widely opened.

Lin et al. [6] mentioned that cultivating students' learning interests and enhancing learning efficiency were urgent problems that required teachers' solutions. The traditional "blackboard and chalk" teaching style was gradually replaced by multimedia instruction. Liu et al. [7] stated that the unique "comprehensive, multi-aspect, multilayer, and changeable" demonstration function of multimedia video-integrated STEM curricula presented many advantages that traditional teaching styles lacked. 1. Vividness, novelty, and intuition, overcoming dull, abstract, and difficult traditional teaching, reinforcing students' question comprehension, and enhancing willingness to learn could achieve the effect of "combining education with entertainment". 2. Enhancing efficiency and saving time for making teaching content, presenting neat and clear "blackboard writing", and increasing information in multimedia video-integrated STEM classes could largely enhance teaching efficiency. 3. Reducing tiredness and pollution: Most chalk erasers could be replaced with multimedia tools or mobile devices to reduce teachers' tiredness and students' copying, as well as dust pollution [8].

Chen et al. [9] indicated that, along with the rapid development of technology, the use of computer-assisted instruction (CAI) and multimedia could effectively help teachers solve the curriculum design problem in STEM education. Teachers could change plain textbooks into dynamic and active forms through multimedia, combine texts, pictures, and sound and light effects, and collect teaching materials through the Internet as a complement. Students, through distance teaching, are not restricted to time and number of times, and learning according to their personal schedules could acquire the best learning achievement in STEM curricula (Johnson et al., 2020). Under the multimedia interaction system, students could decide the learning content and speed according to personal needs to fully satisfy individual needs. Under high participation, students would enhance their attention and cultivate the active learning of STEM curricula to reach higher learning achievement [10].

Zhen et al. [11] considered that lesson plans should be made according to the teaching content in STEM curricula rather than using multimedia for multimedia;

otherwise, the effect of STEM course teaching would not be effective. Van Diemen et al. [12] explained that, with traditional teaching style, students completed the notes during teachers' blackboard writing; however, under multimedia instruction, blackboard writing was not necessary; teachers appeared to have a faster rhythm, but students might not be able to take notes. Providing a STEM syllabus for students' preview could largely enhance the learning effect. Multimedia video-integrated STEM curricula were so student-centered that any lesson plans required teaching design [13]. In addition to basic subject knowledge, teachers had to promote multimedia application skills that complement each other. Multimedia video-integrated STEM curricula should be further intellectualized to intelligently diagnose students' levels, analyze the causes of students' mistakes, and make analytic statistics of all students' mistakes for corrections of next learning content and suggestions [14].

Hong et al. [15] pointed out willingness as the intrinsic process of an individual's conscious, purposeful, and even planned approach to the pursued objectives, which particularly stressed awareness. Students with a higher willingness to learn might continuously participate in learning activities to enhance their personal abilities [16]. Sun et al. [17] mentioned that the current multimedia video-integrated STEM education scene focused on didactic instruction, where the one-way learning model resulted in students' low willingness to learn. Although education departments kept promoting diverse learning and nurture by nature and teachers tried to promote diverse learning methods in the STEM education scene, a lot of parents still considered academic performance more important than diverse learning and even encouraged children to focus on subject learning to result in more learning pain. Shiau et al. [18] explained learning attitude as "happy learning"; people who were happy to use multimedia video-integrated STEM curricula would actively learn STEM or search for STEM-related information. It would reinforce students' self-learning attitude and cultivate the thinking habit.

Li et al. [19] pointed out the important role of learning attitude and willingness to learn in learners' learning achievement. When learners were not willing to engage in teaching, either didactic instruction, apprenticeship teaching, or multimedia instruction would be meaningless. Learners' willingness to learn was induced by instructors' collection and selection of teaching data. Learners' age, preference, and ability, as well as hardware equipment in the teaching environment, should be taken into account in material design to enhance students' learning attitude and willingness to learn. They would be factors in learning achievement [20].

Based on the literature cited above, the following hypotheses are proposed in this study:

H1: Multimedia video integrated into STEM curricula would affect learning attitudes.
H2: Multimedia video integrated into STEM curricula would influence learning achievement.
H3: Learning attitude presents significant and positive effects on learning achievement.

3 METHODOLOGY

3.1 Measurement of research variable

Learning attitude. Drawing from Shu and Huang [21], this study introduces two dimensions of learning attitude:

1. Intrinsic motivation: This includes learners' personal needs, desires, impulses, affections, and emotions. Intrinsic motivation refers to the motivation to undertake a task to achieve a sense of fulfillment or satisfaction from the inherent value of the task itself.
2. Extrinsic motivation: This encompasses motivations, objectives, interests, and ambitions existing in the environment. Extrinsic motivation refers to the motivation to undertake a task in order to obtain external benefits (such as rewards, evaluations, or instructions) that are unrelated to the intrinsic value of the task.

Learning achievement. In reference to Gao et al. [22], the following dimensions are introduced in this study for learning achievement:

1. Learning effect: This covers test performance, the timeframe for task completion, and term performance.
2. Learning gain: This includes learning accomplishment, satisfaction, and preference.

3.2 Research object and sampling data

This study utilized 188 college students from Guangdong Province as the experimental subjects. A 16-week-long (3 hours per week, totaling 48 hours) experimental research project was conducted on multimedia video-integrated STEM curricula. The data were analyzed using SPSS, and various statistical techniques, including factor analysis, reliability analysis, regression analysis, and analysis of variance, were employed to test the various hypotheses.

3.3 Course activity design

Multimedia video-integrated STEM curricula are the research objective. The curriculum design is practiced for 18 weeks, when the experimental group is preceded by STEM with multimedia video and the control group is preceded by traditional teaching. The detailed content and explanations at various stages are listed in Table 1.

Table 1. Course activity design

Weeks	Activities Per Each Week	Brief Description of the Activities
1–2	This stage stresses the introduction and understanding of STEM-related concepts.	The experimental group is preceded by STEM curricula with multimedia videos, and the control group is introduced with a power point presentation as in traditional teaching.
3–7	This stage focuses on the integration of relevant technology and information, assisting with the learning and creation of STEM curricula.	Students in the experimental group are guided to apply distinct multimedia video-related information and reminded of operation points and application. The students could randomly use various multimedia video devices to collect the necessary information and inspiration. The control group in introduced with a power point presentation, as in traditional teaching.
8–12	The stage stresses students' application and practice.	The experimental group finds out the required information or inspiration with various multimedia videos to complete the practice in STEM curricula. The control group precedes practice according to the taught knowledge.
13–17	This study focuses on respecting and appreciating others' opinions and feelings, as well as being willing to correct and combine personal creations to match others ideas.	Students present the clothing design and describe the inspiration source. Classmates have discussions in groups to vote for the ones with excellent performance on practice. The experimental group applies distinct multimedia video, and the control group is preceded by traditional teaching.
18	Experimental result	Teachers evaluate students' practice capability according to the work and test their learning attitude and achievement.

4 RESULTS

4.1 Reliability and validity analysis

Upon employing factor analysis, learning attitude has been observed to be composed of two factors, namely "intrinsic motivation" (eigenvalue = 2.166, α = 0.83), and "extrinsic motivation" (eigenvalue = 1.836, α = 0.85). The cumulative variance explained by these two factors amounts to 72.641%.

Similarly, learning achievement, subjected to factor analysis, yields two factors: "learning effect" (eigenvalue = 4.253, α = 0.90) and "learning gain" (eigenvalue = 3.571, α = 0.93). The cumulative variance accounted for by these factors reaches 87.592%.

Difference analysis of multimedia video integrated STEM on learning attitude. According to the analysis of variance to discuss the difference between multimedia video-integrated STEM curricula in learning attitude, i.e., analysis and explanation of teaching methods, Table 2 shows higher intrinsic motivation in multimedia video-integrated STEM curricula (4.07) than in traditional teaching (3.62) and higher extrinsic motivation in multimedia video-integrated STEM curricula (4.16) than in traditional teaching (3.78). H1 is then supported.

Table 2. Difference analysis of multimedia video-integrated STEM in learning attitudes

Variable		F	P	Scheffe Post Hoc
Multimedia video-integrated STEM	Intrinsic motivation	31.183	0.000**	multimedia video (4.07) > traditional teaching (3.62)
	Extrinsic motivation	35.261	0.000**	multimedia video (4.16) > traditional teaching (3.78)

Note: **for $p < 0.01$.

Difference analysis of multimedia video integrated STEM in learning achievement. According to the analysis of variance to discuss the difference between multimedia video-integrated STEM curricula in learning achievement, i.e., analysis and explanation of teaching styles, Table 3 reveals a higher learning effect with multimedia video-integrated STEM curricula (4.24) than with traditional teaching (3.69) and a higher learning gain with multimedia video-integrated STEM curricula (4.33) than with traditional teaching (3.51). Accordingly, H2 is supported.

Table 3. Difference analysis of multimedia video-integrated STEM in learning achievement

Variable		F	P	Scheffe Post Hoc
Multimedia video-integrated STEM	Learning effect	26.371	0.000**	Multimedia video (4.24) > traditional teaching (3.69)
	Learning gain	33.128	0.000**	Multimedia video (4.33) > traditional teaching (3.51)

Note: **for $p < 0.01$.

4.2 Correlation analysis of learning attitude and learning achievement

Correlation analysis of learning attitude and learning effect. In order to verify Hypothesis 3, Table 4 demonstrates significant and positive influences of both

intrinsic motivation (β = 2.042**) and extrinsic motivation (β = 2.153**) on the learning effect.

Correlation analysis of learning attitude and learning gain. In furtherance of Hypothesis 3 validation, Table 4 exhibits remarkable and positive impacts of both intrinsic motivation (β = 2.189**) and extrinsic motivation (β = 2.267**) on learning gain. Consequently, Hypothesis 3 is substantiated.

Table 4. Analysis of learning attitude to learning achievement

Dependent Variable →	Learning Achievement			
Independent Variable ↓	Learning Effect		Learning Gain	
Learning attitude	β	Beta	β	Beta
Intrinsic motivation	2.042**	0.194	2.189**	0.207
Extrinsic motivation	2.153**	0.204	2.267**	0.215
F	23.657		29.739	
Significance	0.000***		0.000***	
R2	0.243		0.281	
Adjusted R2	0.225		0.264	

Notes: **for $p < 0.01$; ***for $p < 0.001$.

5 DISCUSSION

Teachers could guide students through STEM curricula through multimedia videos. Giving lessons and guiding students to use mobile devices for browsing lesson data in the class allows students to instantly collect and save relevant STEM course content for use in free time or as an assignment reference. Teachers who teach non-specialized subjects could learn with multimedia videos and cooperate with teachers in relevant fields to increase STEM teaching activities and promote students' learning attitudes and achievement. In STEM curricula, students are often grouped for teaching activities to demonstrate teamwork. During the multimedia video integrated STEM teaching process, students, in groups, discuss the teaching data in multimedia video with classmates and are encouraged to share the searched multimedia data, browsed webpages, or interesting app programs to broaden the learning. Multimedia video-integrated STEM curricula requires a network connection, and many classrooms or students do not have Internet, which slows down the teaching speed; not being able to immediately download or upload relevant information results in frustration for instructors or learners. For this reason, the execution of multimedia and video-integrated STEM curricula requires school support for equipment and administration.

6 CONCLUSION AND SUGGESTION

The research findings show that multimedia video integrated into STEM curricula could enhance students' learning attitudes. The result matches the research results of Johnson et al. [23]. Apparently, students expect to understand more of the taught content from multimedia video-integrated STEM curricula, and their learning attitude

is positive. Multimedia video-integrated STEM curricula could provide students with effective learning and ensure that students' learning achievement is positive. The result matches the research results of Zhen et al. [11]. Multimedia video integrated into STEM curricula could enhance students' learning attitudes. The use of multimedia videos provides more opportunities and information for students to understand STEM-related information, and books are not the only source for learning information. In this case, the use of multimedia video is helpful for STEM instruction, and students enjoy its use and operation. Especially, the assistance of multimedia videos could enhance the willingness to learn and creativity of students without their own opinions. Such a result matches the research results of Sun et al. [17].

According to the research conclusions, the following suggestions are proposed in this study:

1. Teachers, in multimedia video-integrated STEM teaching, should encourage students to participate in class discussions, offer opportunities for students to give opinions, guide students to analyze, explain, or comment on problems or events, accept students' various opinions, and patiently wait for students' answers. Furthermore, teachers should often use opportunity education in multimedia video-integrated STEM curricula, give some news or issues, and guide students to discuss and propose personal opinions so that students can cultivate the ability to analyze and criticize in daily life education.
2. Issues in which students are interested should be taken into account for multimedia video-integrated STEM curriculum design. A topic or issue combined with several relevant fields for integrated teaching could save teaching time, and students could acquire the integrated concept and knowledge. Activities and opportunities for planning self-directed learning could assist students in solving real-life problems with the learned knowledge to enhance their willingness to learn and learning achievement.
3. Teamwork, team discussion, and collaborative experiment design are stressed in multimedia video-integrated STEM curricula. In the learning process, team students would provide various opinions for discussing a problem, designing an experiment, or collaboratively making a scientific work to make final decisions. It conforms to the process of STEM education. The integration of multimedia video could therefore enhance STEM curricula.

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