Digital Media Technology Applied in Self-Guided Learning

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This research adopts Keller's ARCS motivation theory as a method to create a teaching experiment by integrating augmented reality (AR) into teaching in order to enhance learning interest and learning effectiveness in a digital media design course. The purpose of this research is to examine the application of AR in quarantine during the COVID-19 pandemic, whereby students can enhance their learning interest, learning satisfaction, and learning performance. Augmented reality acts as a tool for this research, wherein it is applied with the course of a 3D model-based interface and built-in learning contexts for the "digital media design" of the learning topics.
The contribution of this research is proving that AR teaching materials are suitable for normal learning programs during the COVID-19 pandemic. At present, it appears as though online learning and self-study at home will become the norm for the students all over the world. Digital media design was the research field, and the coding program and the project development as professional domain knowledge of the Unity platform were found suitable for AR teaching materials for online learning solutions. However, the limitations of the research are that for successful AR teaching experiences, teachers must devote substantial additional time to work on AR-based textbooks,in contrast to other teaching models, which represents a major impediment for educators.

digital media design augmented reality learning interest learning effectiveness

1. Digital Media Technology Applied in Self-Guided Learning

The wave of global digitalization has rapidly changed operations in the fields of business, education, industry, design, etc. Technology and networks have been popularized for 20 years and have deeply changed aspects of peoples' lives [1]. Higher education is facing challenges, and the need for change is substantial. As a result, digital media proficiency in teaching has become a core component of modern innovative education [2]. In Taiwan, integrating digital technology into innovative teaching has become mainstream in educational reformation. The innovative education perspectives such as digital globalization trend and global visions, as well as development capability, have been widely promoted since 2013 in order to reach the goal of global higher education. The Ministry of Education in Taiwan has proposed that Taiwan's education in the future will be connected with the latest learning technology, media, creative learning methods and environment, as well as a variety of learning programs to construct an innovative method for cultivating talents [3].

Nowadays, students who were born in 1982–2002 are called Generation Y. They have been growing up in a digital age with globalization and unprecedented access to tools of information, self-exploration, and entertainment. Therefore, their learning style mostly focuses on visual, aesthetic, and multimedia interaction. Compared to the

traditional teaching methods in classrooms regarding the learning environment, they are more likely to be willing to have an interactive learning environment where students are actively engaged in the learning process [4][5]. Due to the rapid advancement of digital media technology, industrial society has evolved into the digital era, a society full of digital information that leads and influences the economy and culture. For Generation Y students, they experience the innovative learning trend with the feature of visual thinking, digital narratives, and high-speed networks, which shape their entertainment-oriented learning style and also enhance their ability to operate digital devices and encounter large amounts of information.

Digital media technology includes animation, games, interactive multimedia, AR/VR, etc. These can enhance the Generation Y students' learning performance and learning efficiency, as has been verified by related studies [6][7][8][9][10][11][12]. Through online learning platforms with digital media technology support, education and knowledge can be broadcasted to users from different areas. Users can enjoy flexibility with this online learning platform depending on their situation and adjust the learning speed. The critical features of AR- or VR-based learning are not static but dynamic, and with more than two dimensions that can be wisely seen in most AR teaching materials in the field of education [8][13]. Through AR- or VR-assisted animation, games, or other interactive digital media, a unique learning experience can be provided for students to enjoy unique learning benefits, both physically and emotionally [14]. Regarding the development of AR, Kerr and Lawson mentioned the prototype of AR, Master of Time, which is applied for the education of first-grade students and used for the foundational principles of landscape architecture design. In their research, they found positive results from learning by experiencing AR-based digital media courses in situated experiences [8]. The teaching of landscape architecture education has been conducted studio classroom settings for a long time in university. AR-based landscape architecture education has become an innovative method for landscape architecture teaching. Kerr and Lawson suggested that innovation in education cannot be achieved without a deep understanding of AR digital media technology among educators.

In terms of the teaching materials, teachers can use digital media technology to design more interesting content in order to increase students' interest. Digital media technology has been proved to enhance students' skills, learning effectiveness, learning motivation, self-learning capability, and satisfaction [15][16][17]. Previous researchers have studied the integration of digital media technology into teaching in various contexts, for example, in interior design [6], or in English teaching with digital media [18] and an AR-based classroom [19], and even in cultural preservation and education [20]. Moreover, digital media technology application can support traditional teaching methods, such as with video podcasts or exotic ecosystems that can help enhance students' environmental education [21].

Based on the above-mentioned literature, we can conclude that digital media technology can help Generation Y students understand the contents of their learning programs. Digital media also can help teachers to create innovative programs for students. Thus, the present research takes an AR-based teaching program with digital media as an assisted learning tool for students to learn and experience a new form of education.

2. Augmented Reality Realizes Innovative Teaching

In 1997, the concept of augmented reality had already been proposed by several scholars, such as Azuma with the aspect of systematization [22]. The theory of augmented reality has been practically and positively applied in various countries.

Innovative services based on virtual integrated reality have been widely applied in the field of medicine, and in art exhibitions, electronic commerce, trade show design, industrial product design, tour guidance, online learning, sports training, and physical product digitalization [6]. Through AR technology, virtual 3D images can be simulated as a real-world object and clearly seen from any perspective or angle. Therefore, the user can perceive the stunning visual effects of the combination of the virtual world and real world [23][24][25][26]. The AR 3D objects in the real world can be seen from a mobile phone device that allows a virtual experience for users.

Since the advancement of digital technology applications, real object emulation has become more popular in learning. Real object emulation can include digital technology, 3D models, animated images, as well as situations that can be repeatedly tested [27]. In the realistic virtual world, the environment can allow a user to perceive an impressive experience and also avoid the actual dangers of a real-world situation. Due to the above characteristics, integrating AR technology, 3D, animation, or games into education can be effective for learners to explore the world of knowledge [28][29]. As mobile devices are common, AR application offers more innovative learning content for students, such as real-time interactions with 3D graphics, visualization of 3D models, interactive UI, audio/video content, academic keywords tagging, and infographics [6].

AR allows people to experience a real-world learning environment. AR-assisted innovative applications have more applied value beyond the 2D-based interface with linear video/audio modes in digital learning. By integrating AR technology into a head-mounted display or other display devices, such as an Oculus headset, the digital information can be presented in the user's own perspective and the objects can be perceived in a situation where the real world is combined with the digital world [30]. AR technology enables students to experience various unique interactions as well as to strengthen their self-learning capabilities.

According to above literature review, AR technology may be considered as an effective method to enhance learning interest. Through smart mobile phones or tablets, a student can learn in a simulated situation [31]. Hsu's research results confirmed that the application of AR technology can effectively help students to experience contextual topics and achieve learning goals [32]. Hsu developed two AR-based game systems for learning English in a contextual environment, finding that AR technology can create a ubiquitous learning environment for students to experience. Furthermore, students' learning motivation is also improved by real-time feedback factors as well as the sense of participation. AR technology enable students to experience a ubiquitous learning program and enhance their perception of linguistics, and the result proves that students are more likely to actively learn English through AR technology [33]. Khan et al. [34] claimed their results show that the AR system can improve students' learning motivation and skills. They proposed the ARToolKit-based Interactive Writing Board (IWB) as a learning device that integrates AR technology. IWB can be used to teach Arabic or Urdu to elementary school students.

Based on related studies and literature reviews, this research uses AR technology as a tool to construct a digital multimedia instructional program by creating a ubiquitous contextual learning environment for students in order to examine if applying AR into teaching programs can enhance students' learning performance and learning efficiency.

3. The Learning Motivation Theory

ARCS motivation theory was proposed by John Keller, an American professor who suggests a systematized motivation model based on the motivation theory and other related theories in order to stimulate students' learning motivation [35]. Keller states that learning performance cannot be enhanced if the instructional program design cannot arouse a student's learning interest. Keller expected that educators can take the ARCS motivation theory as a method to confirm and design instructional strategies according to students' requirements in order to arouse learning motivation and effectively enhance learning performance. In 1987, Keller put forward four factors in the theory of learning motivation that can effectively help teachers stimulate students' learning motivation and interest in learning [36]. The four factors are "attention", "relevance", "confidence", and "satisfaction", comprising the crucial elements of the ARCS motivation theory. ARCS motivation theory is used to improve teaching programs and help instructional design. The four elements of the learning motivation theory must be taken into account for instructional design in order to stimulate students' learning motivation [36].

After integrating several motivation theories, ARCS motivation theory has been proposed to strengthen systematized instructional design, which serves not only to provide practical applications and conceptual organization but also to stimulate student interaction and participation in learning activities. The four factors of the ARCS motivation theory are closely related to each other where the educator's teaching performance would be directly affected. The teacher should apply the ARCS motivation theory during the teaching process to facilitate student learning in a positive learning environment. The achievement of the instructional program would be directly affected if one of the four factors of the learning motivation theory is missing during teaching periods. John Keller emphasized that ARCS also has the function of "diagnosing" problems and helping to improve learning ability. This means that if learners are struggling to learn, there are ways to overcome these problems through the ARCS model. In other words, teachers must use more adaptive teaching methods to design textbooks for such students [37].

The four elements of the ARCS motivation theory as well as its definitions are clarified in **Table 1**. Based on Keller's ARCS motivation theory, the definitions of the four elements are connected to the application purpose, which is divided into four parts: learning attention, learning interest, learning behavior, and learning satisfaction [6]. Together, they help teachers to recognize students' learning motivation and also to create an interesting and effective teaching program for students to learn with their full attention during class.

Table 1. The definitions of ARCS model.

Elements	Definition	Variable	Purpose
A Attention	Arouse students' learning interest to stimulate their curiosity in order to maintain learning attention [6].	Learning attention	• Confirm that students are immersed in AR to practice multimedia design learning. • Observe student enthusiasm about the subject matter, and concentration increase in learning.
R Relevance	Students' relevant personal recognition is to be developed by the innovative learning materials [6].	Learning interest	• Take an AR-based instructional textbook as a teaching approach to incite students' interest. • Make students feel that this course is worthwhile so as to motivate their interest in learning.
C Confidence	Arouse students' expectations of success and help them to build positive attitudes so as to help increase their self-confidence [6].	Learning behavior	• AR technology can be useful and practical for students' learning. • The confidence and concentration in learning of students can be improved via AR-based teaching activities.
S Satisfaction	Students' satisfaction can be effectively enhanced during learning by the improvement of self-learning effectiveness [6].	Learning satisfaction	• The AR-assisted learning program can help student self-learning by which their satisfaction, sense of accomplishment, and learning motivation will be effectively enhanced.

The crucial function of the ARCS motivation theory is to help teachers generate an interesting instructional program that can attract learner attention and enliven the teaching materials and also escalate student interest in learning and offer students a positive learning experience. The variable of the "relevance" factor has been defined as "learning interest", which refers to when a teacher creates an appropriate instructional program in order to amplify students' learning interest during class, and meanwhile, during the learning process, students can recognize the knowledge system and realize the learning value. The learning performance and efficiency, however, will be directly affected by attention and learning interest. As a matter of fact, any single element of the learning motivation theory directly influences the others. Learning interest is considered as the core value of pleasant learning [38].

ARCS motivation theory has been widely applied in experimental teaching research. Chang et al. [6] used the ARCS motivation theory and integrated AR technology into interior design to create a real-time visual effects feature and enable students to recognize the problems that may be happening during the interior design and to find the best solution through teamwork. Zheng et al. [17] pointed out that with the ARCS motivation theory, instructional programs can be improved and students' learning motivation can be strictly and objectively evaluated. Chang, Chen, and Liao [19] applied ARCS motivation theory to design an AR-assisted situational classroom for English teaching, and found that it enhanced EFL students' learning satisfaction during the experimental teaching.

Based on above-mentioned statements and literature reviews, this research uses ARCS motivation theory as a tool to validate the effectiveness of experimental teaching. The aspects of the validation include students' learning attention (concentration), learning interest, learning confidence, and AR-based learning satisfaction in digital multimedia design teaching class. I also endeavor to verify if integrating AR technology into experimental instructional programs can help enhance students' learning performance.

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