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INCORPORATION OF DIGITAL TECHNOLOGIES INTO TEACHING ON THE FACTORS INFLUENCING THE LEARNING EFFECTIVENESS OF SCHOOL CHILDREN

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Abstract

As information changes with each passing day, there have been a variety of information and software on the Internet, and textbook publishers have created the videos and electronic books about teaching for instructors. If all the information is integrated with school courses, is it suitable for school children? If digital technologies are incorporated into teaching, what factors will play an essential role in learning effectiveness? Surely, instructors must be careful in the information selection. This study elucidates the factors influencing the learning effectiveness of school children in the incorporation of digital technologies into teaching, sorts them according to weight, and adds the research methods and result analysis, with the hope of helping instructors enhance students' learning effectiveness according to the situation of students and the key factors of learning effectiveness in the incorporation of digital technologies into teaching. Moreover, the achievements are offered to the institutions which develop digital teaching software, so as to give suggestions on planning and provide directions for future studies.

Keywords: incorporation of digital technologies into teaching; learning effectiveness; Modified Delphi Method; Analytic Hierarchy Process (AHP)

Introduction

The rapid development of information and technology has accelerated the global educational digitalization. Taiwan will have laid a solid foundation for overall digitalization by 2020; the U.S. will digitalize all its textbooks; Mainland China has been implementing the 10-year digital education program since 2011. In face of the fast generation of much knowledge ,how to enhance a person's learning effectiveness and achievements has become a global attraction. What is the most frequently used to reinforce learning effectiveness are computer and the Internet. In most teaching in Taiwan, each classroom is equipped with a computer. Usually, instructors would use digital tools to search and supplement what to be taught and then add it into the courses. In this study, priority is given to finding out the factors that influence learning effectiveness in the digital courses. Then, these factors are sorted to show instructors how to effectively improve teaching and learning in the curricular arrangement.

Literature Review

What is digital learning? In digital learning, technological methods and educational meaning are combined and the characteristics of the Internet are utilized to create an environment beneficial for learning [1]. As for the incorporation of digital technologies into teaching, instructors apply technologies to in-class teaching and after-class activities to develop students' ability to use technological information and their spirit of active exploration and research, so that they will be able to think about and solve problems independently and make a plan for their career life. According to the study of Shih and Chiang [2], if well-made teaching strategies were consistent with students' learning effective, students' interest in learning would be stimulated and their learning effectiveness would be increased. In the study where GPS was added into the teaching effectiveness of geometric area for the 5th grade students, Lo [3] found that the incorporation of digital technologies into teaching could strengthen students' geometric reading and that there was significant change to their learning attitude after the teaching. In the study on the benefits of the incorporation of information into the mathematical teaching for the 5th grade students, Peng [4] noticed that digital technologies could enhance the learning effectiveness of boy students. According to the second stage of the information technology education strategy in Hong Kong , digital learning could not only ignite students' passion for learning but also create a happier learning atmosphere thanks to the creativity and interaction brought by technology; hence, it was beneficial to apply digital technologies to teaching. After considering the above research results and suggestions, the author holds a positive attitude towards the incorporation of digital technologies into teaching. Lin and Hwang [5] pointed out that digital learning alone could not satisfy all students' demands on learning and suggested that priority should be given to in-class instruction and then extracurricular materials were offered according to students' response and attitude. According to the academic documents, the factors that influence learning effectiveness can be classified into three types:

1. Instructor:In the seminar of educational technology, 35% of the teachers believed that over 90% of the teachers who attached importance to educational technology in the 21st century were positive that the application of digital technologies could increase the learning opportunities for the students in the school areas; therefore, teachers' ability to use technology has attracted great attention [6]. The arrangement of what to learn is related to the logic of thinking, and an inappropriate arrangement would disturb learners' thinking and then their learning effectiveness, and instructors are the soul figures who play the role. In the Study on the Innovation and Technology Acceptance of Teachers' Application of Interactive Electronic White Board in Teaching in the E-oriented Demonstration Prestigious Schools in Pingdong County, Lin and Chou [7] pointed out that the teachers who were more innovative in teaching showed more support for the incorporation of digital technologies into the traditional teaching. According to the above information, the teaching characteristics of instructors have measurable effects on the learning of learners.

2.Learner:Different children have different learning abilities, but there is a close relation between learning ability and learning effectiveness. Most of the learners who have great learning effectiveness hold a positive attitude towards learning. Chung [8] pointed out that higher academic achievers surpassed lower ones in many aspects, including commonsense, Chinese proficiency, spatial concept, and knowledge acquisition speed. After massive information becomes available, everyone can obtain the information he/she needs from the Internet; hence, the role of students will change from listener in the past to the center of learning; meanwhile, teachers will become a learning helper who leads children to learn actively and develop the capabilities of independent learning and introspection [9]. To enhance learning effectiveness, learners in the digital learning environment play the role who takes initiative to gain knowledge, totally different from the one who merely receive knowledge in the traditional teaching. According to relevant academic documents, many personal characteristics also influence learners' learning effectiveness, such as gender, age, computer experience and skill, creativity, cognitive style, and learning style. Moreover, scholars believe that previous experience would influence learners' implementation of learning strategies in the integration of digital technologies and teaching and then influence their learning effectiveness.

3.Quality and environment of digital technologies :Learning is a process where ideas are transmitted and absorbed. There are several factors which influence the transmission of ideas, and one of them influences information: music, text and language are all signs which include sound, text and letters. Are their permutations and combinations appropriate? The content of the materials for teaching is the foundation, and there is a close relation between foundation and objective. Attention should be paid to the sequence and permutation of content. These digital teaching materials can make teaching more vivid; hence, what to be taught should be constantly improved and modified to meet the trend of the times. The quality of digital technologies influences the learning intention of learners, so all countries have formulated norms for the quality, with the hope of improving digital teaching materials and contributing to higher learning effectiveness. Likewise, the quality of software and hardware is also closely related to learning effectiveness. Liou and Li [10] argued that the main problem in the incorporation of digital technologies into teaching was not the information attainment of teachers but hardware equipment. The problems in software and hardware also affect the integration of digital technologies and teaching. The long-term advancement of digital learning relies on the accumulation of teaching resources, the increase in information equipment, and the improvement of teachers' and students' information attainment. Therefore, in terms of administration, it is critical for institution directors to show support and lay emphasis on the digital environment.

Research Design and Implementation

After defining the research topic, the author of this study read the academic documents, journals and books about the incorporation of digital technologies into teaching, deduced and analyzed the academic documents, summarized the factor dimensions that influenced learning effectiveness, and made the questionnaire, which was divided into two parts—the Modified Delphi Method and the Analytic Hierarchy Process (AHP).

1.Modified Delphi Method: The experts in the Delphi Method focused on the information talents in various fields, including 10 digital technology teachers in elementary schools, 3 digital technology researchers, and 3 experts in digital information textbooks. They undertook a semi-open questionnaire, with a retrieval rate of 100%. The information of the retrieved questionnaire copies was analyzed and deduced according to the scores and views of the experts. The second questionnaire was designed on the basis of the results of the first questionnaire. After the second questionnaire was done, the validity of the evaluative norms was further confirmed, and the consistency of the experts' views was tested. This is the complete process which finally led to the dimensions of learning effectiveness.

2. Analytic Hierarchy Process (AHP):With the teachers in the Zhunan Elementary School in Miaoli County as the research subjects, the author distributed 70 questionnaire copies and retrieved 57 ones, with a retrieval rate of about 80%. All of the teachers were those who had rich experience in integrating digital technologies with teaching. After the decision-making hierarchy framework was established, the hierarchy questionnaire was sent to the teachers, so that they could give some suggestions according to their application

of electronic white boards and regular incorporation of digital technologies into teaching. Then, the results were calculated after the questionnaires copies were retrieved.
The results the expert questionnaire based on the Modified Delphi Method were divided into 4 items and 17 sub-items. The analytic hierarchy questionnaire was designed according to the results. The obtained data were used for the weight analysis to achieve the relative weight of the factors that influenced learning effectiveness.

Research Procedure and Results

The research procedure consists of three steps, which are illustrated as follow and shown in Figure 1:
Step 1: Analysis of academic documents
This study collected and sorted out the academic documents about digital learning and the incorporation of digital technologies into teaching and drew reference from the studies of several scholars to define the factor indexes that influenced learning effectiveness in the incorporation of digital technologies into teaching. Additionally, the question dimensions of the hierarchy analysis and the norms that influenced the evaluation were made.
Step2: Modified Delphi Method
Modified Delphi Method was again adopted for the expert questionnaire and then the result analysis. After the appropriateness of the preliminary evaluative items was confirmed, the semi-open Likert's five-point scale was used for the questionnaire. The questionnaire copies were distributed among relevant scholars and experts. The questionnaire was analyzed, deduced and modified according to the scoring and views of the experts. Then, the second questionnaire was done. This step was the foundation for the making of the "Analytic Hierarchy Expert Questionnaire of the Factors Influencing Learning effectiveness in the Incorporation of Digital Technologies into Teaching".
Step 3: Analytic Hierarchy Process (AHP)
The hierarchical dimensions and evaluative norms were established on the basis of the results of the Modified Delphi Method questionnaire. In other words, the hierarchical classification was systemized to define the hierarchical dimensions and each evaluative norm; the hierarchy questionnaire was designed, distributed and retrieved. After that, the Analytical Hierarchy Process (AHP) was adopted to sort out the questionnaire data, and the MSExcel (2013) and Expert Choice were used for the calculation to analyze the weights of all the decision-making and evaluative norms. Then, the obtained weights were used to find out how much the experts valued the factors.

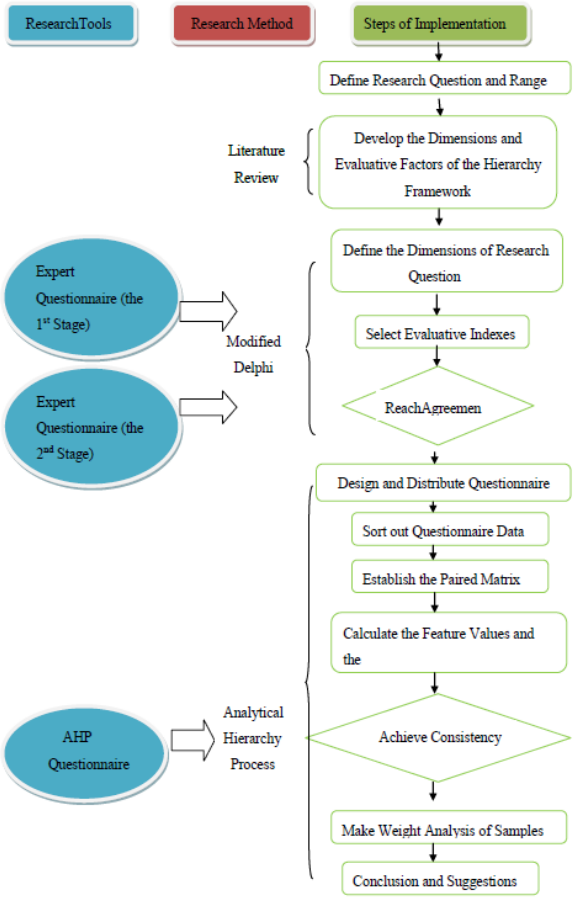

Figure 1: Research Procedure Diagram

The results of this study are based on the analysis of the AHP results. AHP was divided into three parts: Part 1 was the objective layer; Part 2 involved the main norms that influenced learning effectiveness; Part 3 was about the secondary norms. The illustration is as follow:

1.Analysis of the Experience of the AHP Questionnaire Expert Group :This study aims to find out the ranking of the evaluative factors that influence the learning effectiveness of school children among the teachers of Zhunan Elementary School in the incorporation of digital technologies into teaching. Because of the fact that all classrooms of the elementary school are equipped with an electronic white board, the access to the Internet, and electronic textbooks, the teachers of the elementary school were invited to fill in the questionnaire. According to the data, 65% of the teachers had worked as a teacher for over 10 years. This indicates that the experts had rich experience.

2.Content of the AHP Questionnaire :AHP was adopted for the questionnaire in this study, with 4 norms and 15 sub-norms; hence, n(n-1) paired comparisons were needed.
(1)The definitions of the indexes and the instruction on how to fill in the questionnaire are shown in Table 1.

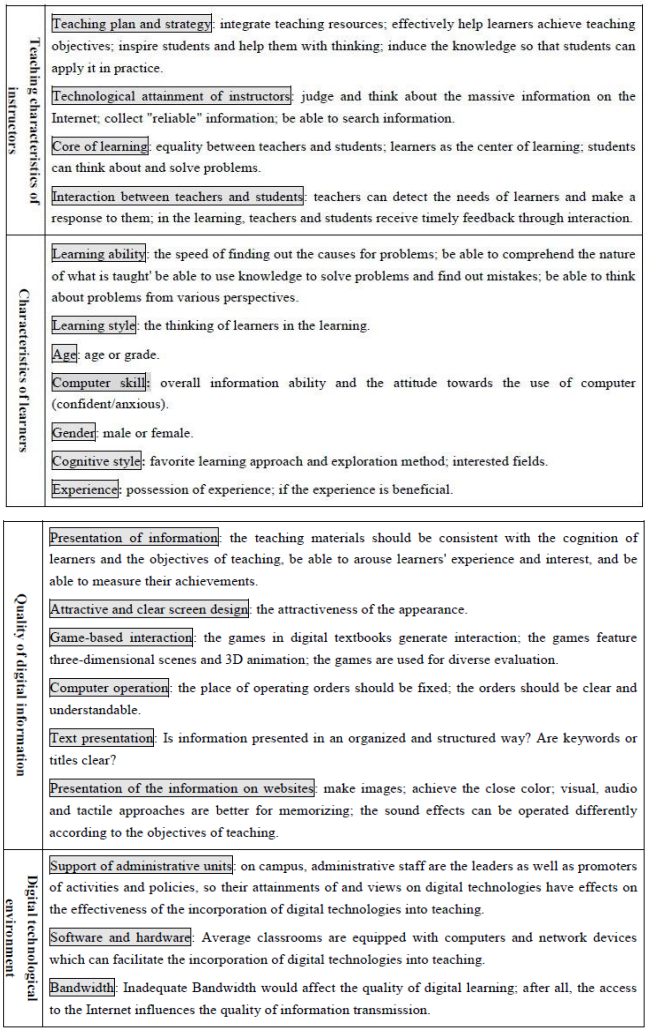

Figure 2: Description of the Indexes

(2).Personal information: gender, age and position

(3).Instruction on how to fill in questionnaire

This questionnaire made the intensity comparison of relevant importance on 9 levels. The influence of each norm on the objectives varies according to the evaluation of the experts. All norms have their relevant weights in the achievement of the objectives, so it was possible to compare the weights of the norms and circle the most appropriate ratios in the evaluation. The measurement scales included "Absolutely important", "Extremely Important", "Very important", "Slightly important" and "Equally important", and there were nine scoring criteria. If an item was thought to be more important, the value closer to the index would be circled.

3.Comprehensive analysis of the factors that influence learning effectiveness in the incorporation of digital technologies into the traditional teaching.

In the questionnaire for the respondent teachers, the teachers attached the greatest importance to "Teaching plan and strategy" when selecting the factors that influenced the learning effectiveness of school children in the incorporation of digital technologies into teaching. As for the main norms, 44.68% laid emphasis on "Teaching characteristics of instructors". In the exploration of single factors, priority was given to "Teaching plan and strategy" in the basic analysis of "Teaching characteristics of instructors"; "Learning ability" ranked the highest in the basic analysis of "Learning characteristics of learners"; "Text presentation" attracted the greatest attention in the basic analysis of "Quality of digital information"; most emphasis went to "Software and hardware" in the basic analysis of "Digital technological environment".

According to the results, "Teaching characteristics of instructors" had great effects, for 4 sub-items in it ranked among the top 5 secondary norm items. This indicates that "Teaching plan and strategy", "Technological attainment of instructors" and "Interaction between teachers and students" had great effects on the learning effectiveness of school children. It can be seen that the teaching characteristics of teachers features some influence, consistency and continuity and that they would influence school children's learning intention and is the most important factor among these factors. Table 2 is the index ranking list of the factors that influence learning effectiveness. The top 3 factors are shown in Table 1.

Table 1: Index Ranking List of the Factors That Influence Learning Effectiveness

Criteria	Criterion weight	Secondary criterion	Secondary criterion weight	Weight multiplication	Ranking
Teaching characteristics of instructors	0.4468	Teaching plan and strategy	0.3895	0.1740	1
		Technological attainment of instructors	0.2538	0.1134	2
		Core of learning	0.1871	0.0836	4
		Interaction between teachers and students	0.2314	0.1034	3
Learning characteristics of learners	0.2946	Learning ability	0.2381	0.0702	5
		Learning style	0.1935	0.0570	7
		Age	0.1797	0.0529	9
		Cognitive style	0.1804	0.0532	8
		Experience	0.2083	0.0614	6
Quality of digital information	0.1515	Presentation of information	0.1404	0.0213	16
		Attractive and clear screen design	0.2399	0.0363	11
		Game-based	0.2028	0.0307	13

		interaction			
		Text presentation	0.2504	0.0379	10
		Information on websites	0.1665	0.0252	15
Digital techno-logical envi-ronment	0.0694	Support of administrative units	0.4081	0.0283	14
		Software and hardware	0.4480	0.0311	12
		Bandwidth	0.1439	0.0100	17

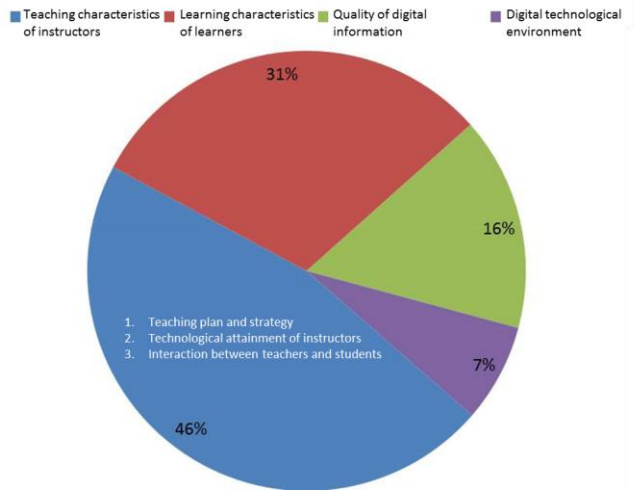

Figure 2: Top 3 Factors that Influence Learning Effectiveness in the Incorporation of Digital Technologies into Teaching

Conclusion and Suggestion

According to the emphasis placed by the teachers of Zhunan Elementary School in Miaoli County on the factors that influence the learning effectiveness of school children in the incorporation of digital technologies into the traditional teaching, the factor indexes were ranked on the basis of weight: the factors attracting high importance accounted for 55%; those attracting intermediate importance took up 26%; those attractive low importance occupied 18%.

1.The factors that attracted high importance are listed as follow: Teaching plan and strategy, Technological attainment of instructors, Interaction between teachers and students, Core of learning, and Learning ability. Most of these five factors are in the dimension of "Teaching characteristics of instructors". This indicates that despite the ever technological advancement and the increasing popularization of the Internet, elementary school students still need to use digital tools under the guidance of instructors. Therefore, the role of teachers is changing, but appropriate curricular arrangement and correct guidance from teachers still have great effects on the learning effectiveness of school children before their abilities are fully developed.

2.The factors that attracted intermediate importance are listed as follow: Experience, Learning style, Cognitive Style, Age, and Text Presentation.

3.The factors that attracted low importance are listed as follow: Attractive and clear screen design, Software and hardware, Game-based interaction, Support of administrative units, Information on websites, Presentation of information, and Bandwidth.

Elementary school education is the most fundamental learning for citizens, especially for children who are the cornerstones of the future development and competitive forces of the country. All countries are investing much labor and money in digital learning, and Taiwan is no exception. However, any investment would not prove worthy unless there is reward. Seeking the factors that can facilitate the incorporation of digital technologies into teaching according to the situation of Taiwan and the actual experience of elementary school teachers is highly significant for the education for children. Only by heading towards a correct direction can prevent us from merely following others and neglecting the national situation and children's characteristics in the investment in the global digital drive. Therefore, if the results of this study on the factor influencing the learning effectiveness of school children in the incorporation of digital technologies to teaching are successfully and continually popularized, they will greatly promote the learning effectiveness of school children.

There are two suggestions for the researchers who will do the follow-up studies:

1.Due to the limited research scope, fund and time, this questionnaire merely targeted at the teachers of Zhunan Elementary School in Miaoli County; consequently, the results only revealed the emphasis placed by the teachers and thus are not applicable to other elementary schools or even other counties. It is suggested that future researchers expand the research scope to the whole Miaoli County or the schools and remote areas in North Miaoli, which will lead to more research subjects.

2.Different evaluation weights can be established according to different subjects, which was not done in this study. It is suggested that relevant studies be done according to the features and needs of different subjects like mathematics, Chinese, English, nature, health and physical education, and music, so as to develop different evaluation items and facilitate instructors' application of digital technologies in teaching.

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