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A Framework of Multimedia Integration Based on Teacher's Perspectives

Chien-Heng Lin^{1*} and Yu-Chiung Lou²

¹*Department of Early Childhood Education, Asia University, Taiwan.*

²*Department of Social Work, Asia University, Taiwan.*

Authors' contributions

This work was carried out in collaboration between all authors. Author CHL designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Author YCL managed the analyses of the study and the literature searches. Both authors read and approved the final manuscript.

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ABSTRACT

Aims: Teacher's role in multimedia integration is not only a user but also a designer and producer, by which teachers can manipulate more appropriate multimedia aids and fulfill teacher's essential needs. In order for a teacher to promote the efficiency and effectiveness of the technology integration in classroom, this study explores the entire process of teacher designer to integrate multimedia materials and induce a framework based on teacher's position so as to help designers in their integration of multimedia materials.

Study Design: This study is based on the criterion of a qualitative approach.

Place and Duration of Study: kindergartens in Taichung City, between May 2012 and February 2013.

Methodology: In total, ten kindergartens, twenty-five classrooms, and thirty-two qualified preschool teachers were involved in this study. The selection of the interviewees and the observation classrooms were based on recommendations by the school principals who were more familiar with their own situation in technology integration.

Results: In the end of this paper, we construct a framework of multimedia integration consisting of five main procedures to illustrate how teacher designers are to proceed their journey of integration. This framework provides a proper guide to teachers who want to

*Corresponding author: Email: jayarama1004@yahoo.com.tw;

integrate multimedia teaching aids in their classroom teaching.

Conclusion: Through the application of this model we expect that teachers can easily design the digital teaching aids which are fit for their real needs and allow teachers' teaching to be more efficient and effective.

Keywords: Computer integration; teacher's perspective; multimedia; multimedia integration.

1. INTRODUCTION

The highly developing of computer technology allows multimedia information to be presented variously and vividly, and the speedy connection of internet allows people to gain information easily and swiftly. Thus, the application of multimedia technology in classroom is very pervasive and is integrated into different levels of education in classroom teaching. The definition of multimedia is a function of computer system which transmits visual and aural information to user interactively [1]. The idea of integration of multimedia in teaching is to connect different multimedia elements, such as text, image, audio, animation, and video, to create digital teaching materials and to apply it in classroom teaching, which intends to improve the quality of teachers' teaching and students' learning [2]. Many researchers claimed that applying multimedia materials can create many positive effects in classroom teaching. For example, there are researchers indicating that the integration of computer technology helps teachers to build a more visualized and more interactive learning environment in their classroom teaching [3]. Researchers also alerted that various products of computer technology are very powerful teaching tool adopted to achieve powerful interactive teaching, which increases learner's interest and help them to engage intensely in their learning objects [2,4]. Many researches also indicated that the application of computer technology has great potential to increase students' motivation, help learners to connect various information sources, provide opportunities to work collaboratively, and allow teachers to have more time for facilitation in classroom [5,6,7]. As [8] declared, one of the advantages of integrating multimedia is that it allows students to assess the teaching content easily and helps them learn to be more effective.

However, some researchers declared that digital media materials have no direct effect on students' learning achievement [9,10]. According to [11] theory of cognitive load, he declared that human's learning in brain is just like a data processing machine, and the learning achievement is based on how people process and arrange the information. Based on this theory, [12] developed multimedia cognitive learning theory and advocated theories of how multimedia elements influence student's learning effect. They declared that too many multimedia materials or inappropriate arrangement in teaching may cause negative influence on student's learning achievement [13].

Therefore, the integration of multimedia in teaching does not simply focus on how many digital materials are involved in the curriculum but how proper the materials are used. The volume of using multimedia is not the main concern. What we really need to focus on is how to utilize this strong tool to create positive effect in teaching and learning [14,15].

In order to promote the efficiency and effectiveness of the technology integration in classroom, numerous frameworks are constructed to help teachers to involve computer technology in curriculum ably and efficiently [16,17,15]. However, researchers and educators indicated that integrating computer technology into curriculums has not been accomplished

well yet. Researchers indicated that teachers have not really integrated digital technology into their classroom teaching but only into their personal documentary work. These developed frameworks or models are too theoretical and idealistic in reality [15] and do not consider the angle of teacher user and teacher designer normally [18]. Even if teachers can understand some principles, design concepts, and standards, they often forgo these principles and frameworks in actual teaching implementation. Therefore, researchers suggest that digital technology integration must take into account of teachers' specific habits of applying technology [19,20,21].

Furthermore, due to the heavy load of teachers' daily routine work, teachers used to adopt the published multimedia materials for assisting their teaching, such as instructional CD-ROM, DVD, or internet platform. However, these published digital materials do not fit teachers' essential needs normally. Teachers only can adopt only limited useful parts of the published materials and strive to reorganize the content. Therefore, the current packages of digital teaching aid do exist with a great gap between teacher's actual need in teaching. On the other hand, it is quite time-consuming for teachers to find appropriate multimedia teaching aids. These have brought tremendous obstacles for teachers in multimedia integration.

To solve these problems, teacher's role should be transformed from user to both designer and creator. Due to the pervasive use of computer technology, teacher's competency of using computer technology has been improved tremendously, and increasing numbers of teachers can operate and design multimedia materials. If teachers can arrange and produce multimedia teaching aids by themselves, the integration of multimedia in classroom teaching will be more effective and efficient and close to teachers' actual needs. However, from being a user of digital material to being a designer does exist a gap and prove long way to go. For this reason, this study tends to explore the entire process of how teacher designer integrates multimedia materials in classroom teaching and to induce a framework based on teacher's position to help his/her integrating multimedia in their teaching. Therefore, the research question of this study is to investigate what a teacher may experience in the entire process of integration and to clarify various kinds of consideration, difficulty, possible problems, and solution which a teacher designer may meet in his/her integration.

2. MATERIALS AND METHODS

The research method in this study was based on the criterion of a qualitative approach. Teachers' views of how they integrate computer technology and the entire process of how they integrate multimedia material were investigated. Both approaches of in-depth interviews with teachers and observations of the real classroom teaching were adopted. A semi-structured interview technique was adopted as our research interview method was due to the main topics being fixed, although the sequence of our interview question was not necessarily the same for all interviewees, as shown in appendix. All interviews were audio-recorded and the transcriptions were completed on the same day. The classroom observation was implemented with note taking and video recording concurrently by the researcher.

Instead of random sampling, purposive sampling was adopted in this investigation [22,23]. Through contacting and visiting numerous kindergartens which are well known for integrating multimedia materials in their curriculum in Taichung City in the middle of Taiwan, researchers selected the research participants who were more willing and appropriate for this study. In total, ten kindergartens, twenty-five classrooms, and thirty-two qualified

preschool teachers were involved in this study. The selection of the interviewees and the observation classrooms were based on recommendations by the school principals who were more familiar with their own situation in technology integration. The period of each classroom observation was at least five days and was supplemented by referring to the teacher's lesson plans. The number of participants was decided by saturation of the researched data, that is, when the informants could raise no more new issues and start to repeat the same issues as compared with previous interviewees or classroom observation, it may be valueless to collect more data.

Through a series of qualitative analysis steps, the researcher analyzed the collected data systematically from the raw data corpora, generated codes, and built some initial low level concepts; thus gradually we developed some more abstract themes, and then substantive theories were constructed in the final stage [24]. The qualitative analysis of the data helped us to refine and deduce how kindergarten teachers integrate computer technology into classroom teaching, and how they apply multimedia materials to designing digital teaching aids for classroom teaching. These results provided the researcher with various themes and codes to help constructing a substantial model for teachers in their integration of multimedia.

3. RESULT AND DISCUSSION

This study is based on the empirical investigation of teacher's actual use of multimedia in their classroom teaching. This research deeply looks into teacher's considerations, challenges, and struggles when they integrate multimedia into their classroom teaching. The process of designing and making digital multimedia materials was also explored. Through the inductive analysis of the qualitative data, the researcher concludes a framework with 5 procedures for teachers in their integration of multimedia, as shown in Table 1. The sequent procedures are: preparation and analysis, plan and design, detail manufacture, test and modification, implementation and reflection. Every procedure has consideration in detail. The sequence of the identified procedures has a logic connection with the former and latter procedures. These identified stages start from the macroscopic self-analysis to the intermediate arrangement, to the microcosmic practical manufacture, and back to the amendment, and finally to the macroscopic amendment and reflection from user and learner.

3.1 Preparation and Analysis

In the first stage of the procedure, the researcher concludes that teachers have to do self-evaluation including teacher's internal factors and external factors from teacher's environmental reason. This stage strongly influences whether teachers will actively or passively integrate multimedia into their classroom teaching. If teachers' perspectives of using multimedia in this stage are pessimistic, they tend to decide not to use multimedia as their teaching materials. This stage is much closer to teachers' self-analysis of their motivation of adopting or using multimedia. The influenced factors can be divided into two parts: the internal self-analysis and the evaluation of external environments. The former includes teachers' perspective and attitude of adopting multimedia in teaching, teachers' confidence and competency of using multimedia, teachers' will or motivation to spend time and effort on it. One teacher with a positive perspective declared that:

In fact, I am very interested in multimedia stuffs. When we turn on the computer, it is full of multimedia information. These are very useful materials, and I believe it can bring very positive effect in classroom teaching. According to my observations, students seem to have

very good responses to multimedia teaching aids. Personally I am very willing to use or make multimedia teaching materials. (T16)

The other teacher with a negative opinion declared that:

I think young children should reduce the stimulations from digital multimedia. They are surrounded by different kinds of digital materials and overused them. I feel it is too early for them to contact digital materials and so on. Habitually I don't use digital multimedia in my classroom teaching because I don't think it can bring any help in my teaching and students' learning. (T6)

Furthermore, many teachers believed that their computer competencies were not sufficient and lacked of knowledge and experiences of using digital multimedia so that they might feel anxious for using multimedia. The other consideration was the time consuming. Many teachers claimed that to adopt multimedia materials needs to spend more time in organizing and editing digital materials. To sum up, the above considerations, many teachers do tend to give up using multimedia in their classroom. One of the teachers commented that:

At the time when we were students, multimedia technologies did not exist yet. These new stuffs are what only the young generation can use. To be honest, we cannot use them at all except the easy one, for example, PowerPoint. Our working load in everyday's routine work is already very heavy. To spend more time learning and making multimedia materials for classroom use is not practical and realistic. (T14)

Thus, teachers have to experience this internal self-evaluation procedure in the initial stage. They have to overcome their negative perspectives to multimedia and increase their willingness to use it in their curriculum. As researchers have reported, a teacher's computer attitude or computer self-efficacy will decide whether the teacher will adopt computer technology in the teaching [25,26,27,28].

Except teacher's internal factor, there are still many essential external factors which may affect teacher's use of multimedia and which need to be analyzed and examined in the initial stage. Through the analysis of teachers' perspectives in this point, the researcher concluded five external factors which might influence teachers' decision of applying multimedia materials. Those are support from school ideology and policy, school equipment of computer software and hardware, support from school manager (principal or director), technique aid and consultation, and peer review and support. Teachers advocated that once these external factors are supported, they may willingly integrate multimedia into their classroom teaching.

In my school, the policy is to encourage teachers to use and make multimedia materials. The principal has proposed this idea a lot. She thinks it is a future tendency to be digitalized for teaching. Every Wednesday's routine meeting she arranged some teachers who often used multimedia for teaching to teach and share how they have worked in integrating multimedia. I think the equipment for using digital multimedia in my classroom is quite sufficient. Each classroom has a computer and a projector....Actually I will not use multimedia materials in my teaching if our school doesn't support these essential facilitators. Due to the request and advocacy from the school supervisor, we have no option but just follow this order without hesitation to integrate multimedia in teaching. (T21)

I think the implementation of adopting multimedia for teachers' classroom teaching was mainly influenced by the school adviser or principal's recognition and advocacy. Teachers normally will not do this work actively. In fact, they are required by their supervisor to use it; for example, teachers are asked to make student's digital portfolio. Every student will have one CD or DVD disk with multimedia elements on it. They have no choice but just have to complete this job. (T18)

Researchers claimed that school leader has great influence on teacher's use of computer technology [29]. Researchers also alerted that school-related policies, equipment support, and teacher professional training of multimedia technology have played an essential role for teachers to integrate multimedia in their classroom teaching [30]. Their research also reveals that school policies are often underdeveloped and underutilized in developing teacher's use of technology in classroom.

Therefore, to be a multimedia user and designer, teachers have to implement self-analysis of their perspective and confidence of applying multimedia in teaching and extinguish whether their external environment has sufficient support. If these considerations were not to reach certain level, teachers might not go forward to the next procedure of integration. If teachers are lack of confidence in involving new technology for teaching after the above considerations, most of the teachers may decide to neglect or abandon this new tool [14].

3.2 Plan and Design

When a teacher's internal and external motivation are satisfied, the teacher designer may have the motive force to move on further. Once teachers have entered the process of planning and designing, there are several points which the researcher has concluded need to be considered carefully. This stage focuses on the design of the whole integrative picture or plan which includes decision of learning objective, arrangement of curriculum and pedagogy, selection of multimedia resource, and methods of integrating into teaching activities. Teachers in this stage need, firstly, to decide their teaching objective, do lesson plan, and design teaching activities which can reach their teaching goals. Secondly, they have to think about what or which multimedia resources are available, what teacher's ability of editing multimedia is, which activities need to involve multimedia, what place in the activity should involve multimedia, and how to deposit. One of the respondents claimed:

The most difficult part of integration of multimedia for me is how to design and involve multimedia in curriculum and teaching activities. It means I have to decide which place, what kind of, and how to use multimedia in teaching.... On the other hand, we have to consider its essentiality. We use it because we do need it, and we expect it to create good influence on our teaching and students' learning. (T2)

As researchers have advocated, the role of using technology is to be an effective and efficient tool but not to be a purpose [31]. [15] coincided that designer has to justify why the use of multimedia is essential, what value or advantage it will create, and how it can support classroom teaching. Thus how to plan and arrange multimedia to be a useful and effective teaching tool is the main task for teacher designers to consider and think carefully in this procedure.

3.3 Detail Manufacture

After teachers have planned the method and strategy to integrate multimedia in curriculum, the next step is to make the idea materialized. In this procedure there are three dimensions which need to be concerned by designers: teacher user, student learner, and expression of the multimedia content. Firstly, we have to consider whether it can be easily operated by user and whether the interface of operation should be too complicated. The inconvenient and complex interface used may cause problems for teachers to their operating. This discontinues teachers' teaching flow and disturbs students' concentration of learning. As what [22] have emphasized in the usability of the technology, the designed digital material has to be operated easily. Even though the content is plentiful and attractive to learner without convenience and ease for user to use, the tool still cannot reach its expected achievement. One of the participants claimed that:

What we hate most in teaching with multimedia is the complicated operation procedure, unfriendly operational interface, or unsolvable technical problems for teachers. For example, when we have to play a video file, we may need to try different driver or need to install new software. To deal with these operative problems causes interruption of my teaching and break student's concentration on learning. Sometimes the problems may not be solved instantly, teachers are forced to quit the lesson and substitute with other activities. (T11)

Thus, a teacher who wants to be a designer has to consider several essential elements in the views of user when they are making digital teaching materials, such as whether it can be operated easily by user, is it too complicated, have we selected the proper computer software, and so on.

Furthermore, a designer also has to conceive the angle of learner including their age, studying grade, learning style, and cognition level, and so forth. For example, the ability of preschool students to recognize abstract script is not sufficient. They need to use more graphic, image, or animation to facilitate their comprehension of the information. In this case, teacher designers can reduce the part of script illustration and aid some more digital materials with cartoon characters, which can activate learners' learning motivation and interest. However, some teachers indicated that using too many multimedia materials may cause opposite influence to student's learning effect and efficiency. Designers also have to consider learner's limit in the volume of learning content and time of concentration. One of the teachers has commented that:

As we can usually observe when we play video program or cartoon for students to watch. In the first minutes they are so attracted by the program. Once it is longer than 10 minutes, some students start to lose their concentration, talk to their neighbor, turn their head and look around, or leave their site..... Although these digital materials are very attractive to them, we can see that it doesn't always work and needs to be arranged properly (T28).

This point coincides with [13] explanation in the theory of cognitive load. Based on the idea of cognitive load, human being's learning is limited, and too much information and stimulation in the teaching may cause increase of student's cognitive load, which may reduce learner's learning effect and efficiency. Due to the consideration of learner's nature of learning, teachers can avoid the mistake of inappropriate use of multimedia and bring more positive effect to students' learning [32].

Beside, in this stage whether the multimedia has presented the teaching content properly need to be thought carefully. When designers have transformed or manipulated the teaching content into the multimedia materials, they have to check the completed work to see whether it has missed or deviated from the main teaching stream. As one of the participants' comment has said:

We may choose many digital teaching aids or materials to help our teaching. However, on many occasions, the chosen materials have limited components related to our teaching objectives which can be adopted for actual teaching. Teachers used to put all the materials into their teaching even though these are very slightly related to their teaching objective. Sometimes the published digital materials may contain various subjects. When teachers use it in the unrelated topic, students may lose their focuses easily. Therefore, it is a very essential issue for teachers to spend more time to filter the right materials for their teaching use (T7).

Furthermore, in this stage designers have to consider whether their designed multimedia aids have involved the function of interactivity. The interactivity in multimedia teaching has been emphasized by many researchers [33,29,34]. The interaction of multimedia can be classified into four types: learner-instructor, learner-content, learner-interface, and learner-learner [35]. In this stage the researcher emphasizes the interactivity between instructor-content. Except teacher's teaching pedagogy has to be interactive, the interactivity between teacher and multimedia plays an essential role in facilitating teacher to teach interactively. One teacher commented that:

Traditionally, the idea of multimedia integration is alone to play video or animation with CD-ROM driver and have very little interactivity between the teacher and the students. Nowadays, the technology of multimedia has been developed swiftly and can allow designer to develop the interactive function for user to operate. For example, on the operational interface, it increases the controlling function, such as pre-page, next-page, pause, back to the main menu, hyperlink click, etc. These interactive controlling functions allow teachers to operate more fluently and create more opportunities for them to teach interactively. (T22)

Moreover, the expression of multimedia teaching aids usually consists of several multimedia elements [2], such as the electric picture book involves still images and words, and the animation of picture book involves the element of words, images, animations, and auditory effects. Thus, in this stage teacher designers have to decide what multimedia elements are appropriate to be applied in their work, and they also need to choose what multimedia software is more convenient to be operating and can create the best effect.

3.4 Test and Modification

When the first edition of the multimedia is completed, we will go to the next stage of check and modification. Before we start to use the completed work of multimedia teaching aids, it is very essential for us to confirm whether it has defect or gap and to amend those inaccuracies to be proper. As one teacher has mentioned:

According to my personal experience, when we check the first edition of the completed digital work, we usually find some gaps or defects in the original design and this may be far from our initial expectation. This is because the problems or difficulties appear only when we

are dealing with the details. Therefore, it is very necessary to go back to the original idea, check the present work, and then do the proper modification. (T26)

In this stage, teacher designers usually need to go back to the second and third procedure of the entire process to investigate all the details about whether the designed multimedia has fulfilled our teaching needs. These may include whether the content of the multimedia can reach the teaching objectives, the digital materials are convenient and easy to be used, the expression of multimedia materials are artistic and can create student's learning interests, and the arrangement of the sequence and time are suitable and allows learner to obtain the best learning effect. This process can be completed through peer review, by which teachers or school supervisors estimate and conceive what possible results may be caused, what aim the multimedia may reach, and then what modification may be done. Once they discover the fault, the designer may need to go back to the second procedure to reorganize or the third procedure to remake until the final check has been completed in this procedure, and then we can apply it practically in actual teaching in the next step.

3.5 Implementation and Reflection

When the former process of modification has been completed, the next step is to implement. The completed multimedia aid was used to the classroom teaching practically, and the feedbacks from teachers and students will be collected in this stage as well. The feedbacks from teacher's teaching, student's learning, and peer review have to come back to the designer. Through clarifying the feedbacks and suggestions, teacher designers can inspect their work and accumulate more experiences of multimedia integration. This process of reflection not only can help designers to correct the defect at this time but also help to avoid making the same mistake in the future integration. It also offers an example for other teacher designers to refer. One teacher commented that:

When I was using multimedia to help my teaching, I could always uncover what was missing, what was lacking, and what was not proper. Through few times of experience of integration, I improved a lot and have less confusion and obstacle now.... Our colleagues do learn from each other. In Wednesday afternoon we have a routine meeting. We used to share our work with using multimedia to other teachers and check others' work, too. We got the experiences and suggestions from colleagues' checking and reflection. (T9)

The reflection may consist of various aspects: school policy, teacher's individual motivation to the practical design, detail manufacture, and the implementation in the classroom teaching. The following list concludes the significant points in the procedure of reflection, which contains the aspects of multimedia factors, pedagogies, teaching objectives, and facilitation from school.

- Whether the software and hardware equipment or facilitation are sufficient?
- Have the school policy or school supervisor supported adequately?
- Whether the teaching activities with multimedia aids can help to achieve the teaching objectives?
- Whether the multimedia technology can effectively assist the process of activity teaching?
- Whether we have better substitution to replace the present way of using multimedia in teaching activity?
- Whether the application of multimedia material has been arranged properly so that it helps students to achieve the best learning effect?

- How to construct the multimedia teaching aid efficiently, usably, and artistically?
- Whether the designed or used multimedia materials are fit for the learner's learning character?

3.6 A Model of Integrating Multimedia in Classroom

Based on the above analysis and discussion, a model of multimedia integration can be constructed based on the views of teacher designers and the process they have to go through, as shown in Fig. 1. The model consists of five main procedures and links up a dual funnel form to unfold and connect their relations in the process of multimedia integration. This model illustrates how a teacher designer proceed his or her journey of integration from the macroscopic view of applying multimedia to the microscopic detail manufacture and then come back to the macroscopic view of modification and reflection.

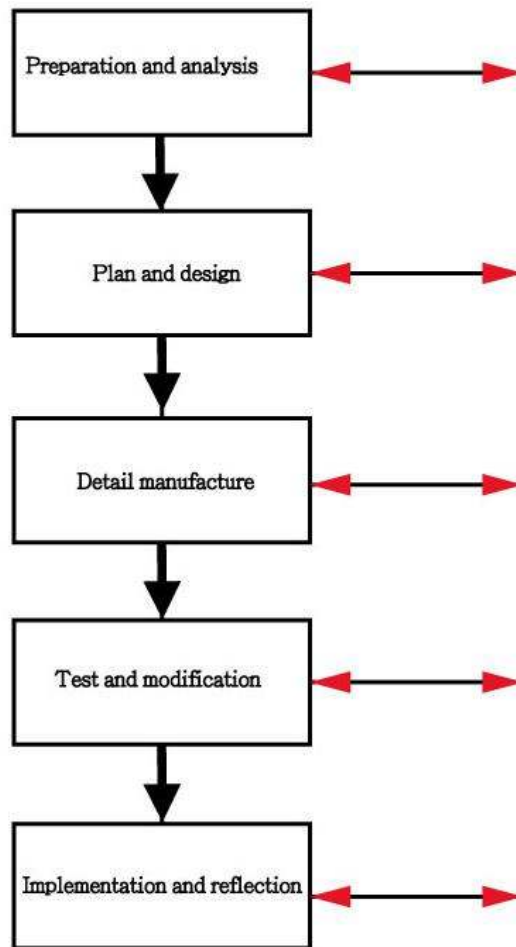


Fig. 1. A model of integrating multimedia

In the initial stage, teacher designers need to do the superficial self-analysis in some aspects and to do the initial preparation for their decision of multimedia integration. The self-analysis

includes teacher's subjective perspective and will of using multimedia and the objective evaluation of the environmental support. The result of the self-analysis in this stage may influence teachers' motivation of continuing to apply multimedia materials in their teaching. When they have experienced the macroscopic analysis stage, they enter into the plan and design procedure. In this stage, designers narrow down their vision to the curriculum arrangement and strategies of integration, and they have to plan where, how, and what the multimedia can be involved in the teaching activities. The followed procedure is to go into the process of detail production. Teacher designers have to focus on doing every single multimedia component, which needs to consider various points of view from the user and learner so that the way of multimedia content can be expressed. Once the digital multimedia is completed, it still needs to be tested and modified. In this stage, teacher designers need to pull their views back to the higher stance, examine whether the completed multimedia aids are proper to be used, and then adapt it again. When the modified multimedia teaching aids are first implemented in the classroom teaching by teachers, these aids may not be used perfectly at this stage. User, learner, and teacher designer may reflect some deficiencies or suggestions. Therefore, designers need to push themselves to a deeper and broader viewing angle and conceive every procedure of the multimedia integration carefully. Through this reflection procedure teacher designers can find out the apt way to improve their integration and accumulate more experiences to help their next multimedia integration to be more effective and efficient. Every procedure in the model is reversible, which can go back to the previous stage to do examination and modification.

4. CONCLUSION

Technology integration in classroom teaching has been a trend, which is not possible to be reversed [16,17,36]. However, the present published multimedia materials are difficult for fulfilling individual teacher's needs, so teachers cannot always rely on the existed baggage of digital materials. Teacher's role in multimedia integration is not only a user but also a designer and producer, by which teachers can manipulate more appropriate multimedia aids and fulfill teachers' essential needs. Only few models of integrating multimedia or computer technology are based on the stance of teacher and on the analysis of the integrating process. In this paper, the researcher constructs a framework of multimedia integration based on teacher designer's perspectives of designing multimedia teaching aids and the integration of digital teaching materials in teaching. This model describes an entire process of how teacher designers construct an integration of multimedia in their teaching. This model also provides a proper guide to teachers who want to integrate multimedia teaching aids into their classroom. Through the application of this model, the researcher expects that teachers can easily design the digital teaching aids which are fit for their real needs and allow teachers' teaching to be more efficient and effective.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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APPENDIX

Questions of Semi-Structure Interview

1. What is your perspective of using multimedia technology in classroom teaching?
2. What are your considerations before you decide to involve multimedia technology in your teaching?
3. Could you please tell us what challenges and obstacles you may have to face when you integrate multimedia technology into classroom teaching?
4. Could you please share with us how you manage and arrange multimedia technology in your classroom teaching?
5. Could you tell us what the main concerns are when you are making multimedia teaching aids?
6. What are the students' responses after your teaching with multimedia technology?
7. What is the reflection of your integration of multimedia technology in classroom teaching?

Table 1. Significant factors emerge from the analysis

Identify category	
Preparation and analysis	Internal self-analysis(teacher's perspective and attitude of adopting multimedia in teaching, teacher's confidence and competency of using multimedia, and teacher's will of using computer technology)
	Evaluation of external environments (school ideology and policy, school equipment of computer software and hardware, support from school manager, technique aid and consultation, and peer review and support).
Plan and design	Design teaching objective Lesson planning Design teaching activities
	Searching available multimedia resources
Detail manufacture	Making interface for teacher user Making interface for student user Expression of the contents
Test and modification	Confirm whether it has defect or gap Amend inaccuracies to be proper
Implementation and reflection	Using the digital aids in the classroom teaching Clarifying the feedbacks and suggestions Significant points in the procedure of reflection,

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