

Enhancing Understanding of Online Content Using Design Factors in Different Multimedia Genres

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ABSTRACT

Many studies applied multimedia and modality-based instruction to learning and teaching in the twenty-first century; they afford an authentic learning experience. This paradigm shift has pushed learning forward based on computer-based media since the early twentieth century. Many previous studies showed that using visual and verbal multimodal media can help to increase learning efficiency. However, most investigations seem to focus on a single mode of media to increase learning efficiency. It is difficult to use these results to claim that one medium can be suited for every type of content since every medium has its limitation of capability. This paper examines three types of media genres: an unanimated slide presentation, blended info- and motion- graphics, and an interactive game. These media were applied to an online course of Introduction to Information Technology in Data Communication and Networking for 286 undergraduate students at Mae Fah Luang University, Thailand, during 2015 and 2016. The results show that the students chose to learn from the blended info- and motion- graphics and the interactive game more than the unanimated slide presentation; the interactive game is more attractive to the students if it is enjoyable. The most significant media design factors that encouraged and helped the students become self-learning are content to design (87.5%), continuity and color design (80.4%), and sound design (78.6%), respectively. Image, sound, motion, and interactivity are multimodalities that helped to keep learner attention. The most appropriate length for media such as the blended info- and motion graphics learning activities was about 5-10 minutes.

Keywords: Multimedia Application, Enhancing Learning Experience, Comparative Media, Online Course

1. INTRODUCTION

Scholars applied digital multimedia technologies to many learning frameworks, especially in distance ed-

ucation; this distance learning focuses on the competence of media technology as educational media [1]. These media were integrated into the learning process in many ways: text-based learning, web-based learning, and game-based learning. To achieve learning goals, educational scholars try to apply different multimedia frameworks, methodologies, and techniques into the learning process through a variety of modes such as text, images, symbols, sound, animation, and interactivity. Digital multimedia are created from the multiplicity of modes to provide learners with a chain of meaning-making; the multiplicity of modes are written text, image, sound, and interactivity. Thus, multimedia; for instance, motion graphics, interactive media, and game share some design fundamentals and features such as visual elements, visual operators, and visual principles [2]. The visual elements refer to essential visual design elements such as line, point, and color, while visual principles and visual operators are referred to guidelines and rules to organize the visual elements to create images; these are called visual grammar. However, different kinds of media have different main components and attributes [3], and these lead to media with different dominant features such as websites, infographics, motion-graphic, interactive media, and games. This study will adopt the concept of visual grammar and applies it to investigate further in an online learning context. People can apply multimedia to a learning process for beneficial purposes for various cognitive functions associated with a variety of learning styles. Education researchers have raised many questions about the integration of media in the classroom learning in terms of appropriate media and technology for learning, better media genres(types) and types of technological learning tools which are better suited for learning; this also includes seeking the appropriate multimedia for self-learning through comparing media genres[4]. Yengin et al. asserted that beneficial media genres and different teaching methodologies could not be compared; however, media technology can support learning in terms of mass delivery, cost productivity, visualization, and multimodal functions. They suggest that media technology should be implementing through distance learning in order to obtain accurate results of comparing media genre efficiency. Yengin mentioned the problematic comparison between media genres and teaching methodologies; however, it is challenging to

Manuscript received on July 20, 2017 ; revised on January 9, 2020.

Final manuscript received on January 25, 2020.

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DOI 10.37936/ecti-cit.2020141.92747

justify between media genres and teaching methodologies (or teaching approaches) since they are both never be used in separate in the teaching context. Scholars usually integrated media into teaching approaches as a component of teaching and learning. Gee[5] also claimed that the emerging of digital media and learning is contributing to a new study that is composing between education and communications to be multiple disciplines. This new study is concerned about how people can be made reflective rather than get meaning from media only. Yengin, additionally, suggested that if scholars need to compare them, they have to set in the same treatment condition.

Westera [6] reviewed the advantages of using media in distance education; media can be used to controlling the perceived loss of traditional instructional delivery methods and for extending the face-to-face models. Educational media are used to support interhuman communications such as expressions, exemplifications, communication, and consolidation of human thought; it can be used to create new opportunities for intensifying human cognitive capabilities[7]. Using media in learning is one of the avenues for education expertise; another is state-of-the-art knowledge of instructional design and associated technologies. Cheng et al. applied a game with the content of human immunology into the classroom and found that the game is not only used for playfulness, but it can help student learning [8].

The previous study proved that integrated multimedia in distance learning are advanced for the self-learning process; further investigation in this research area should focus on how to create capable multimedia to enhance learning. However, several earlier studies emphasized on technical issues or media design methods; they were almost using a holistic approach and repeated learning activities, excluded good visual design and emphasized on mass learners[9], [10]. Additionally, those studies were too much focused on a specific context with a small classroom; they have limitations when adopted for current learning approaches[11]. The study requires making emphasis on features of media design in specific learners and context in order to create effective multimedia for learning.

This paper is developed and extended from the previous publication[1]. This paper aims to investigate: (1) the effectiveness of each type of multimedia that promotes self-learning in the online course, and (2) multimedia design factors affecting content learning through the online course.

The design of multimedia requires associating with the component of the design, such as design principle, interactivity, visual elements, and sound design. This component of the design is what Goodman[12] calls the 'symbol system'; it refers to modes of appearance or sets of elements. In this study, the authors also assessed the design of media's features including the

length of the media presentation and learning experience; additionally, the integration of all components of media design with subject content aims to help students engaging in authentic learning: deep learning, understanding key concepts and applications to real life[13]. This paper studies three types of media genres, which are an unanimated slide presentation, a blended infographic, and interactive online games; these media are applied to the course content of Introduction to Information Technology for 286 undergraduate students in Thailand. This study concerns multiple significant factors: class size, teaching and learning patterns in association with media integration, background knowledge of learners, and cultural contexts for learning, including the medium of instruction, content matter, and psychological factors. This study intends to investigate active multimedia genres by applying them to an online course for enhancing self-learning experiences. This study applied both quantitative and qualitative methods by using the following research tools: an online-questionnaire, interview, pre- and post-test, and content analysis. Moreover, the paper employs a qualitative media design in terms of media integration with the interactivity between content, learner, and type of media.

2. CONCEPTUAL FRAMEWORK

The assumption of this study is based on online learning is an essential course for first-year students; these students can access online content anywhere and anytime. The conceptual framework of this study is illustrated in Fig. 1; the first step of the investigation is how to integrate learner constraints and course content. The study selected the content from the course 'Introduction to Information Technology'. The investigation examined in three different media genres: an unanimated slide presentation, blended info- and motion graphics and an interactive game; the second and the third medium were designed in a similar story concept but with different visual design, audio and interactivity.

2.1 Conceptual Framework

Fig. 1 illustrates the conceptual framework of related multimedia applications to support active self-learning. Knowledge contents are the main concerning learning outcomes in this study.

Learner background such as language and technological skill, age, background knowledge, and available online course access is considered to choose the multimedia application and platform. This concept is used to design specific media applications through the online course.

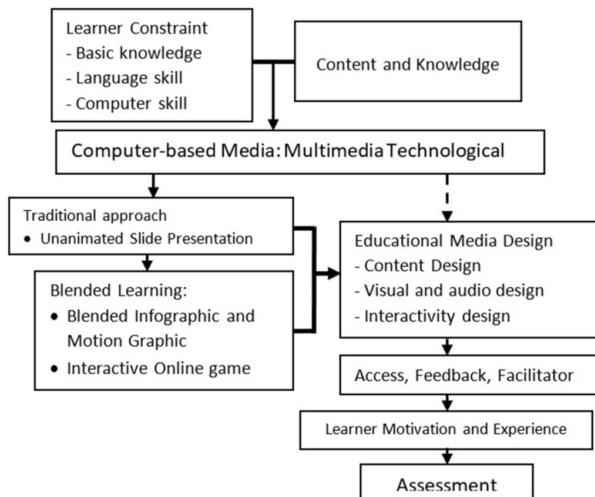


Fig.1: Conceptual Framework of Comparative Multimedia.

3. METHODOLOGIES

Data communication and Network topics were chosen from the course of Introduction to Information Technology as the main contents of applications. The main reason is that these two topics have been problematic for the non-information technology student; most students had gotten a low score in especially these two parts. This study examined the content of the three types of multimedia applications: an unanimated presentation, infographic, and interactive online game. The three media applications had been tested with different non-information technological undergraduate students in Mae Fah Luang University, Thailand. This study adopted and adapted both quantitative and qualitative methods, including a variety of research tools: questionnaire, interview, pre- and post-test. Statistical software is applied for the analysis.

3.1 Research Design

The research design in this study comprises eight steps: subject contents selection, media type selection, media production (unanimated slide, infographic, and interactive online game), randomized class selection, experimenting, data collection, and data analysis and conclusion; this process follows the diagram in the Fig. 2.

3.2 Scope of Research

This study focuses on three types of multimedia applications: traditional(unanimated) slides presentation, which has been customarily used, an animated infographic, and interactive online games are newly created. These applications are applied with the course of the first semester at Mae Fah Luang University, Thailand, during 2015. This subject belongs to the general education courses in which every

first-year student from fourteen schools has to enroll except a student from the School of Information Technology. The four classroom sections were randomized from a total of thirty-six classroom sections. The total contents of this subject are Introduction to Information Technology, Operating System: Windows, Internet: Google Apps, Documentation: Microsoft Word, Presentation: Microsoft PowerPoint, Spreadsheet: Microsoft Excel, Database by Excel and Data Communication and Network. However, this study selects only the content of Data Communication and Network, which are hard for the student without the experience of IT.

The assessment of this study is implemented through the online questionnaire; all students who participate in this study have to do both the pre-and post-tests in all three kinds of media. The questionnaire comprises two main sets of questions: knowledge and media design factors and motivation.

3.3 Media Design Framework

The contents of data communication and the network had been selected to design the central concept in three applications. All contents need to be integrated into the frameworks of multimedia application; it can be shown as the following details 3.3.1 to 3.3.3.

3.3.1 Unanimated Slide Presentation

The unanimated slide presentation has been used as the traditional material in this online course; they are fifty-three slides. This material consisted of text, diagrams, and images in order to create the content. Students were able to download it for self-reading.

A. Data communication

- a. What is Communication?
- b. Communication Systems

B. Network contents

- a. Networks and benefits
- b. Network media
- c. Categories of Networks
- d. The structure of networks
- e. Network topologies

3.3.2 Blended Infographic and motion graphic

This application has been created by integrating infographic and motion graphics based on the same content of data communication and network.

The framework was used to design a narrative storyline of info- and motion graphics (Fig. 3). In this study, the content had been brought to simulate a flooding disaster situation, and the students were encouraged to solve the problem in order to evacuate themselves by using the knowledge of data communication and networking. A three-act scenario is based on the following text:

“A typhoon from the South China Sea has swept into China for more than half a month. It has

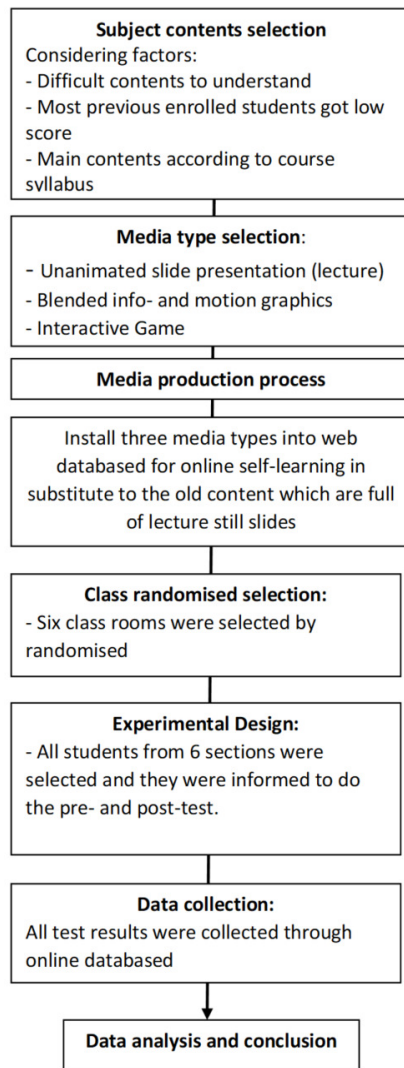


Fig.2: Research design framework.

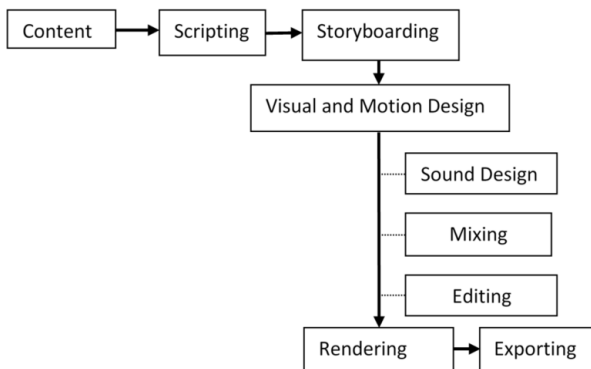


Fig.3: Design framework of Blended info- and motion graphics[1].

caused flooding over a wide area, including Northern Laos, Myanmar, and Thailand. Subsequently, a severe earthquake followed; it caused the dams in Chan to break. The mass influx of water flooded several areas, especially lowland areas in the Chiang Rai province and the area near the river. People cannot connect with the outside world. Many people have been alerted to the run-up to the highland area, but there are some people trapped in buildings, such as the governor of the province. This governor building has a communication device that can be used to call for help from the outside world. Moreover, it has a robot and a manual to help guide for making a network connection.”

This script is later used to create the info- and motion graphics; this medium was built based on various software: Adobe Illustrator, Photoshop, After Effect, and Pro Tools to create dialogue and sound effects. The Adobe software set is used to create the visual design: characters, props and set of the story scenario, and Adobe After Effect is utilized to design motion and animate the characters, including the visual effects. Pro Tools is using to design sounds, mixing, and editing sound(Fig.3). The sample sequence of scenes is shown in Fig. 5.

This medium is uploaded into the online course as one of the learning materials; however, the students require to do the pre- and post-test before and after watching this short video, which was about 6 minutes long.

3.3.3 Interactive Game

The interactive game was designed similarly to the story concept of the blended info-and motion graphic, which consists of flooding disaster situations. The students have to complete the task of the game in order to help people evacuate from the flood. The game was designed as a two-way communication; students have to interact with the game items by choosing the computer equipment in order to ask for help from the outside world. The concept of game design is illustrated in Fig. 4. This concept is utilized to design the game; it can be another called game design flow chart.

Creating the game it requires several kinds of software which are Adobe Illustrator, Adobe Photoshop, Unity, and Pro Tools. The characters, props, and sets are built from Adobe software set: Photoshop and Illustrator, besides the game interactivities and events of the game story, are programmed by Unity software. According to Fig.4, the game needs to verify and play-test before launch and uploaded into the online course through the web databased. The completed game is installed in the online course; the storyline of gameplay scenarios can be shown in another figure (Fig. 6).

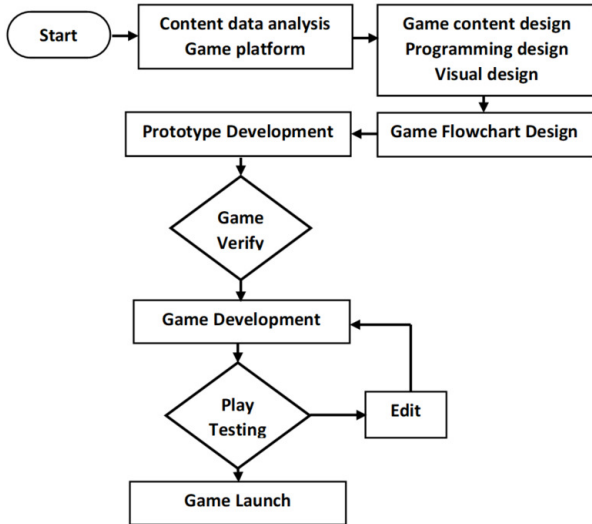


Fig.4: Diagram of game design concept[1].

3.4 Multimedia Applications Design

3.4.1 Unanimated Slide Presentation

This medium consists of fifty-three pages of the slide presentation. These slides have both text and still pictures but without motion images, interactivity objects, and sounds.

3.4.2 Blended Infographic and motion graphic

It has a length of approximately six minutes; it comprises text, graphic, moving image, and sound. Moreover, it also has an English subtitle for an international student. The scenario of the blended infographic and motion graphic can be illustrated in Fig. 5. These scenes are randomized and captured by Media Player software.



Fig.5: Random scenes from Blended Infographic and Motion Graphic[1].

3.4.3 Interactive game

This game is a kind of task game. The game initially offers knowledge about the contents of data

communication and network. The players later have to complete all game tasks by choosing the correct network types of equipment in order to comprehensive the game. Fig. 6 exhibits the gameplay scenarios which randomized and captured by Media Player software.

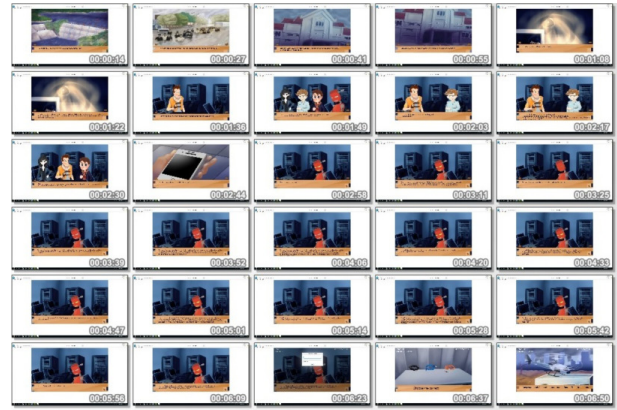


Fig.6: Random scenes from Interactive gameplay 'Lost Connection'[1].

Most students frequently spent about 15-20 minutes playing the game and complete the game tasks. Figure 6 shows the narrative story of the online game; the students had to register before playing the game. The gameplay was about 7 minutes.

Regarding the research design in this study, by using three diverse media types to illustrate the subject content in different ways, this method can benefit, especially for other disciplines, which are more complex and challenging to understand and take a long time to read the content. This can cause reading boring for students. Some subject content is hard for students to conceptualize; applying it to a visual and aesthetics form, which is full of fun, will encourage them to better learning. The student can gain knowledge content from the experience of play[2].

4. RESULTS

Concerning the investigation, the three multimedia application had been tested with 286 first-year students; nevertheless, the students had to complete the Pre-test online questionnaire before using and playing media and games and do the Post-test online questionnaire after they finished three media. The results can be demonstrated in the following details.

4.1 Unanimated Slide Presentation

The scores from both pre-and post-tests of reading the slide presentation are illustrated to the graph form (Fig.7). The content of data communication and network are separated into ten main questions; the average of ten scores shows in the following graph. Regarding the experiments, fig.7 shows that students who use only the slide presentation; this media can

help them to increase the highest score of up to 17.9% compared to the pre-test score. Conversely, the average scores of the post-test display that only half of all numbers of content (50%) that students can improve scores.

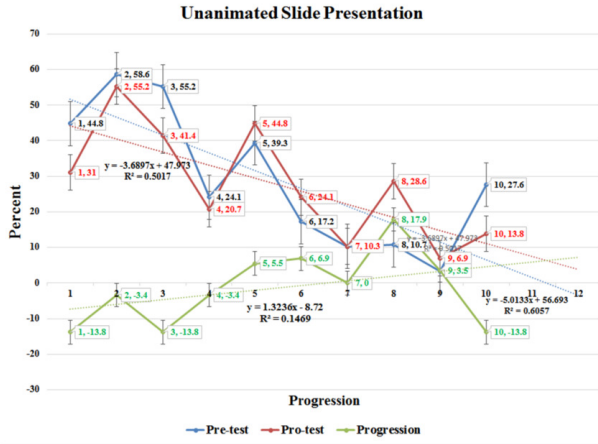


Fig.7: Comparing score of Pre-test and Post-test from Slide presentation.

The progression of the average comparing score between pre-test and post-test can be expressed in the linear equation (1), as in

$$Y = 1.3236x - 8.72 \quad (1)$$

The progression graph shows that the slide presentation can help the students to gain content knowledge moderately because students can increase their knowledge, only 50% of the total content.

4.2 Blended Infographic and motion graphic

The next result of the experimental test is the scores from students who learn the content from the blended infographic and motion graphic; the average answering scores from ten questions are shown in Fig. 8. The result of the score test can be displayed as Fig. 8. Students who learn from the blended infographic and motion graphic acquired the average score of post-test higher than the pre-test; this highest score can be increased up to 15.7%. The progression of the increasing score can be presented as the following equation (2).[1]

The learning progression of the average comparing score between pre-test and post-test displays in the linear equation, as in

$$Y = 0.4418x - 0.52 \quad (2)$$

According to the comparing score graph in Fig.8., all students gain the post-test (red line) score higher than the pre-test (blue line). More difficult questions, more students get the right answer; this reflects the potential of this kind of media that can help students

to understand more knowledge contents. The progression score is increasing steadily. Summary report, students can get the knowledge of content from making use of the motion graphic as the learning tool.

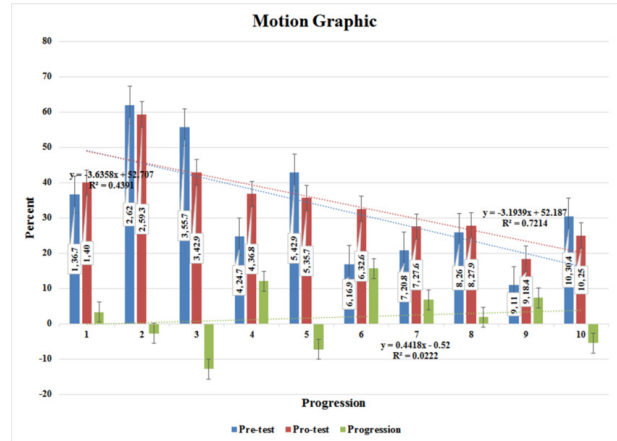


Fig.8: Comparing score of Pre-test and Post-test from Motion Graphic.

4.3 Interactive Game

The result of the final media is also tested with the students in the first year. Students who play and learn the game; they can get the average post-test score up to 80%. The highest score can be increased to 15.4% comparing to the pre-test score; this result shows in the fig. 9.

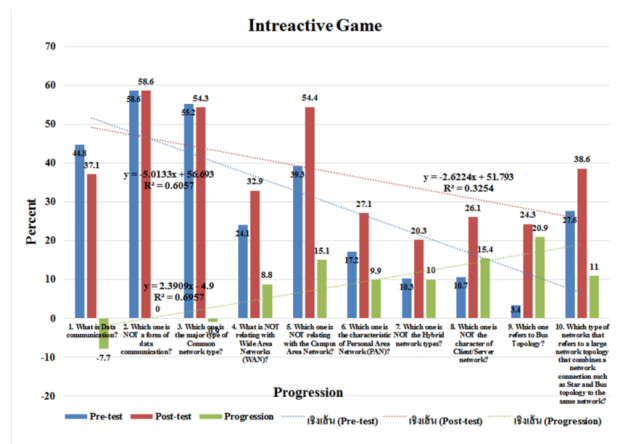


Fig.9: Comparing score of Pre-test and Post-test from Interactive Game.

The progression of content knowledge in which students obtain from the interactive game can be demonstrated as the equation (3). [1]

$$Y = 2.3909x - 4.9 \quad (3)$$

Concerning the result, all average students get the post-test score (red line) higher than the pre-test (blue line).

line). The progression graph and equation show that most students can gain content knowledge steeply. This interactive game can be used as the learning tool to help students to gain knowledge of content, both data communication, and network significantly.

4.4 Comparing result of three multimedia applications

Taking the post-test score results of three media types to compare together, the comparing score result of the three multimedia applications displays as the Fig. 10. The graph shows three different line colors, which are green, red, and blue; they refer to the average post-test score of the Interactive game, blended motion graphic, and slide presentation, respectively.

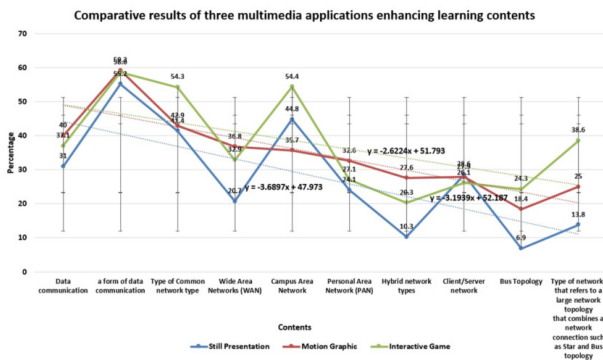


Fig.10: Comparing the result of three multimedia applications.

Concerning the comparing score of three multimedia applications in Fig. 10. The interactive game assists mostly student to get a higher score than the other two media, while the still presentation does not help them much improving the score. On the other hand, the three types of multimedia assist students in gaining the high mark and obtain the knowledge contents of 'Type of common network type,' 'Campus area network,' and 'a form of data communication.' Hybrid network type and Bus topology contents are confusing for the general students without IT knowledge; this experiment found that most multimedia applications did not help students to get a better score. The three media types did not show different results of encouraging students to understand the contents of 'A Form of Data Communication' and 'Client/Server Network.'

In summary, the blended infographic and the interactive game are multimedia applications that raise students to get a better knowledge of content comparing to the ordinary slide presentation or, in other words, the traditional lecture note. Furthermore, may students desire to use and play with these two kinds of applications; this is supported by the result of the amount of preferable media in Fig. 14. Stu-

dents chose the motion graphic and the interactive as their preferable media at 48.15% and 44.44%.

4.5 Comparing the progression of the examination results of using four media types in online learning

Extending the results of pre- and post-test analysis from all three media, this can take the further investigation by comparing their progressions with the progression of using all media together; students have to use all three media at the same time. This experiment is comparing four groups of media using in the online course: slide presentation blended infographic and motion graphic and mixed all three media. The web database system allows one group of students to access all three different media types at the same time; the pre-test and post-test are applied to measure as a summative assessment in this examination. The result of this experiment can be separated into two parts: score progression and media content design.

Table 1 and Fig. 11 show the comparing scores of the pre-and post-test from the four groups of media using; it demonstrates that the students who learn from integrating all media types get the highest total post-test score (441.3%) compared to other students who only use a single media type. The second and third-highest total scores of the post-test are the interactive game (373.7%) and the blended info-and motion graphics (346.2%), respectively. The unanimated slide presentation shows the result in the lowest total score post-test at 276.8%. All students have one-time opportunity to access the content and complete the assessment. The progression of the pre-and post-test scores from watching all media types is shown in the linear equation and R-squared (4), as in the following:

$$Y = -3.9x + 65.58; R^2 = 0.5986 \quad (4)$$

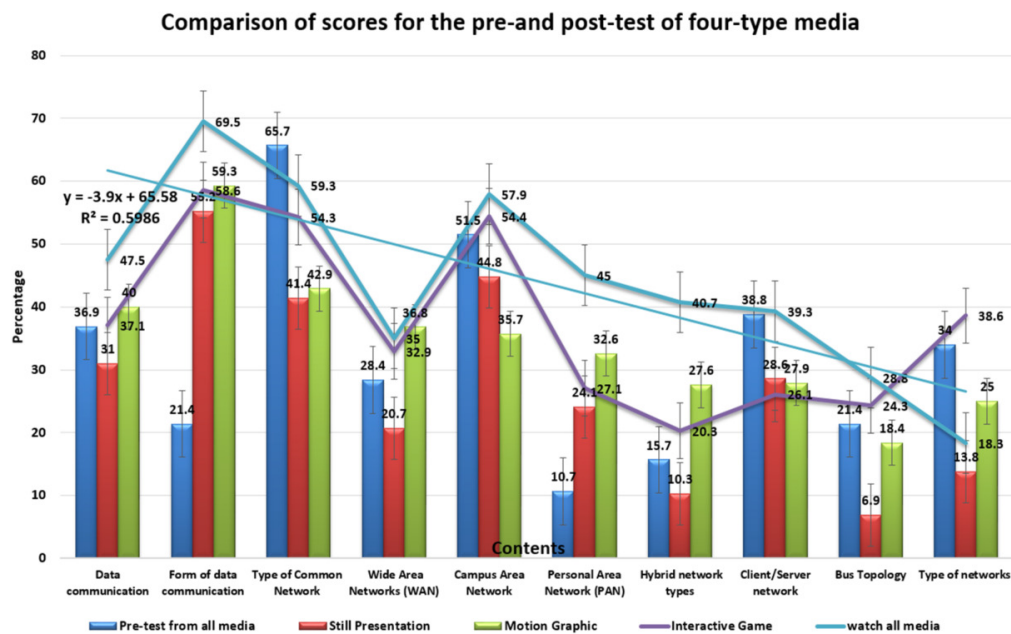
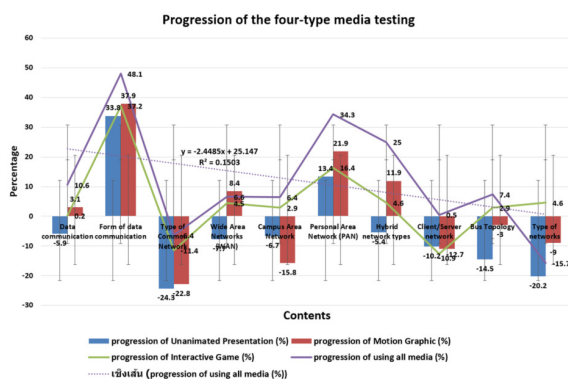
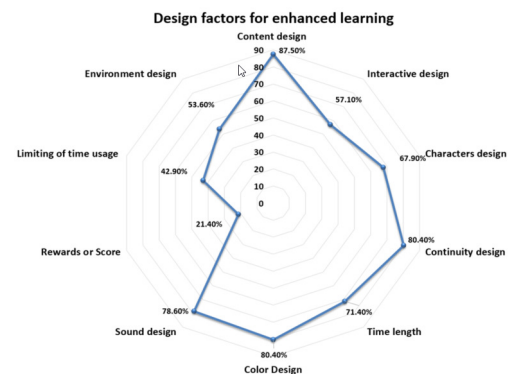
Additional analysis of the extending of the pre- and post-test in Fig. 11, it can be shown in Fig. 12: the progression of the using four-group media scores.

Fig. 12 shows the progression graph of learning from all media types; it indicates that students who use mixed all media get the highest value in comparison to other media types, and the interactive game has the second-highest value. This result is consistent with the scores of pre-and post-test shown in Fig. 12.

Concerning the analysis of the pre-and post-test in three types of media (4.1-4.4) and score progression (4.5), the results show in a similar direction that the students gain the highest value from using integrated all the media types, and the interactive game is the most significant effective media for enhancing self-learning through the online course.

Table 1: Comparison of the progression of examination results of three media types including mixed all media.

Topics of Content	Pre-test (%)	Unanimated Presentation (%)	Progression of Unanimated Presentation (%)	Blended Info- and Motion Graphics (%)	Progression of Motion Graphic (%)	Interactive Game (%)	Progression of Interactive Game (%)	Watching all media (%)	Progression of using all media (%)
Data communication	36.9	31	-5.9	40	3.1	37.1	0.2	47.5	10.6
Form of data communication	21.4	55.2	33.8	59.3	37.9	58.6	37.2	69.5	48.1
Type of common network	65.7	41.4	-24.3	42.9	-22.8	54.3	-11.4	59.3	-6.4
Wide Area Networks (WAN)	28.4	20.7	-7.7	36.8	8.4	32.9	4.5	35	6.6
Campus Area Network	51.5	44.8	-6.7	35.7	-15.8	54.4	2.9	57.9	6.4
Personal Area Network (PAN)	10.7	24.1	13.4	32.6	21.9	27.1	16.4	45	34.3
Hybrid network types	15.7	10.3	-5.4	27.6	11.9	20.3	4.6	40.7	25
Client/Server network	38.8	28.6	-10.2	27.9	-10.9	26.1	-12.7	39.3	0.5
Bus Topology	21.4	6.9	-14.5	18.4	-3	24.3	2.9	28.8	7.4
Type of networks	34	13.8	-20.2	25	-9	38.6	4.6	18.3	-15.7
Total	324.5	276.8	-47.7	346.2	21.7	373.7	49.2	441.3	116.8

**Fig.11:** Comparison of scores for the pre-and post-test of four-type media.**Fig.12:** Comparison of the progression of the four-type media.**Fig.13:** Comparison of the progression of the four-type media.

4.6 Effectiveness of media content design

According to the analysis of the three different media types in Fig. 13, students choose different design factors that influenced their learning; these design factors comprise content, interaction, characters, continuity, time length, sound, limiting of time usage, and environmental design.

Students choose the design of content to be the first significant factor that affects their self-learning (87.5%). The other significant factors are color and character design (80.4%) and sound design (78.60%). Rewards and scores are less important factors for learning media design. However, students selected media for their learning by different criteria.

Table 2 demonstrates that several students choosing the blended info-and motion graphics are the highest at 48.15%, and choosing the interactive game is the second most popular media at 44.44%. Nonetheless, some students prefer the unanimated slide presentation because of they do not like the blended info-and motion graphics and the interactive game.

Students choose different media for their self-learning for various reasons; for instance, students choose the interactive game because students found that the interactive game is fun, easy to understand, attractive, and easy to remember. However, other students choose the blended info-and motion graphics media by other criteria because it is easy to watch, easy to understand, containing beautiful graphics and presenting in a straightforward content, bright illustrations and easy to read and many content details. These reasons are consistent; as a result, shows in Table 2, which suggests that the content of the media needs to be designed well for reading and easy to understand.

Table 2: Comparison of the progression of the four-type media.

Preferable media	Amount of selection	Reasons for selection
Unanimated Slide Presentation	3.70%	- dislike other media
Blended Info- and Motion Graphics	48.15%	- clear illustration - easy to read - provide more info details - color and image help to understand; it saves time - easy to watch, easy to understand - attractive graphic - completed content - clear explanation, easy to listen - short time
Interactive Game	44.44%	- easy to remember - fun - get attraction - better explanation - want to follow - easy to understand - provide a content faster - simulation as real - interaction
Both Blended Info- and Motion Graphics and Interactive Game	3.70%	- Like both

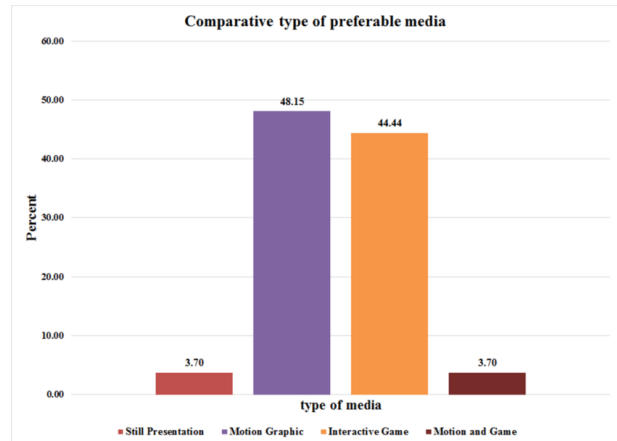


Fig.14: Comparative type of preferable media.

5. CONCLUSION

Regarding the investigation of using all media types, the interactive game provided students with a higher score on the pre-and post-test in comparison to the other two media types: slide presentation and blended info-and motion-graphic. However, watching all media types together resulted in better learning. Students prefer to use the interactive online game and the blended info-and motion graphics for their self-learning rather than the slide presentation. The design factors that encourage the students to learn are content design and visual design, such as color, continuity, and sound. The results suggested that design the interactive games for learning, the content design should be more transparent and easy to read and understand. The media length should have no longer than 20 minutes; the appropriate length is about 5-10 minutes.

Future research should focus more on the content design factors, especially the interactivities, and how to design the media for complex and challenging content in broad disciplines.

ACKNOWLEDGEMENT

The author would like to thanks all research assistants and multimedia students who helped to collect data and built multimedia applications. Moreover, the author would also like to thank Mae Fah Luang University for funding this study.

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