INTERACTIVE MULTIMEDIA LEARNING: INNOVATING CLASSROOM EDUCATION IN A MALAYSIAN UNIVERSITY

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ABSTRACT
This research study was conducted at INTI International University, and aimed at enhancing the quality of classroom learning for University students with three important emphases: Gagne's instructional model, multimedia, and student-centred learning. An Interactive Learning Module (ILM) was developed as the core component in forming the multimedia-mediated student-centred learning environment (MMSLE) to improve the quality of student learning. The impacts on student learning were investigated through pre-test and post-test, questionnaires, open-ended questions and interview. A significant improvement was found in the test results, and shows that this learning environment has enhanced the students' learning achievement. Students also show positive attitude change as they became more active and motivated in the learning process. A framework named MMSLE was proposed to provide a guideline for educators in Malaysian Universities to foster education innovations as alternatives to the conventional classroom teaching and learning methodology.

INTRODUCTION
In this 21st century media-suffused environment today, the advancement of technologies has stimulated the production of more interesting and effective approaches in teaching and learning context. The resulting educational innovations have driven more creative developments for the interactive technologies in various forms, such as computer-based instruction (CBI), intelligent tutoring systems (ITS), integrated learning systems (ILS), computer aided assessment and computer mediated communication. These new concepts and the developments show that the advances in the digital era have broadened the learning processes and enabled higher levels of learner interactions in order to make learning more meaningful for overcoming the insufficiency in rote learning (Dembo & Seli, 2012). In the 'Blueprint on Enculturation of Life-Long Learning for Malaysia 2011-2020', it states that in conjunction with the advances in technology and growth of information, the delivery of knowledge needs to be more flexible in linking the learners with the learning resources to support the independent and self-managed learning. It highlighted that in gearing toward the status of developed nation by 2020, Malaysian education system needs to build two elements: creativity and innovation, as the enablers to equip the citizens towards the high-income level (MOHE, 2011). As such, innovative teaching and learning design at university level is needed to empower the strength of 21st century learners, and it is this change that has directed many universities today to emphasize on innovative education and embed student-centered learning approach into the course design. Educators are trained to transform from the conventional teacher-centered approach to student-centered learning approach with technology-backed learning environment which can better motivate students to participate and interact with others in the learning process. According to Manson (2007), a well-planned learning environment can enhance the quality of learning and encourage students to demonstrate their understanding in the learning activities, so students are given more choices to determine their learning experience. This helps the students to strengthen self-esteem and develop high level thinking skills in a learning community (Suh, 2011). As multimedia-mediated content is incorporated into the learning environment, the information-rich presentations make the learning instructions more effectively than presenting through a single medium in rote learning, so the students can obtain the information more meaningfully and repeatedly through different media and choices (Reeves, 1998; Shank, 2005; Dembo & Seli, 2012). Studies show that with the use of instructional design model, it organizes media-rich information more systematically with the integration of various instructional strategy components (Qureshi, 2004). Robert Gagne (1985) proposed a computer-based instructional design theory which elaborates the organisation of the learning events based on prerequisite relationships. Based on Gagne's instructional design framework, there are nine events of instruction to guide the process of designing for learning contents (Green, 2003).

According to Tuparov, Tuparova and Peneva (2004), in the process of developing the computer-based learning program, the concern is not on "what technological tools are to be used during the development process of e-learning program", but it is on "how to design and plan an e-learning program that ensures the achievement of the learning objectives". This explains that the expanding growth and competitive advantages in the technologies can easily cause the negligence of the pedagogical methodology due to the duration for developing a complex e-learning program is usually shorter than implementing a pedagogical research and testing. In addition, many universities in Malaysia have been upgraded the teaching and learning facilities to further equip with multimedia and web technologies, high speed internet connections to facilitate student learning, as well as encouraging educators to incorporate innovative approaches to enhance the competence of Malaysian graduates. Therefore the purposes for this study are: 1) to enhance the effectiveness of learning content from the planning of the learning activities to reduce presenting contents disorderedly and students dropping out during the learning process; 2) to redesign the learning context at university level by employing a suitable instructional model as a guideline for improving the organization of the content in a student-centred learning environment instead of merely providing information in the learning program.

This paper presents three main parts: 1) the development of an interactive learning module (ILM) with its content focuses on delivering a part of syllabus. This ILM employs multimedia-mediated content and incorporates Gagne's nine instructional events as the design framework to be used in the student-centred learning environment at INTI International University; 2) the identification and discussion the student learning performance and their attitude change in the learning process; and 3) concludes with a conceptual framework for a multimedia-mediated student-centred learning environment (MMSLE) to provide insights to the educators in Malaysian university for developing a more effective learning environment, to complement the conventional learning environment and enrich students' learning experience. The outcomes of this study will be used to answer the research question, "**What are the impacts of Multimedia-Mediated Student-Centred Learning Environment (MMSLE) on student learning?"**

STUDENT-CENTRED LEARNING IN UNIVERSITY CLASSROOM

Due to the advantage of cost-effectiveness in conveying large amounts of information, conventional classroom learning is still being practiced frequently although this approach was found to be the least effective teaching method and less capable to support self-paced learning and interactions between the instructor and learners (Tinio, 2003; Griffiths, Oates & Lockyer, 2007). According to Dale (1969), learners can retain 5% of what is heard, 10% of what is read, 20% of what is obtained in audio-visual presentations and the retention rates can be increased to 70% and above when encouraging the learners to do hands-on practical work in learning process. This shows that learning environment is important in retaining the retention in the learning process (Dale, 1969). Therefore, it is not suitable for all learners to gain knowledge when presenting different levels of information with equal facility, such as learning complicated lessons with the classroom lecture (Booth, 2007). As a result, many learning environments today are moving towards student-centred learning approach which putting students at the centre of the learning process by focusing on their needs (Griffiths, Oates & Lockyer, 2007). This has transformed today's learners to be active participants with more alternatives in identifying the learning goal, obtaining necessary resources, and making some decisions in the learning process, rather than just passively receiving what was given or be controlled by the teachers (Dane, 2004; Griffiths, Oates & Lockyer, 2007). Recently, an increasing number of computer-based programs are designed with the concept of student-centred learning and placing increased responsibility and accountability on the student part (O'Neill & McMahon, 2005). By having the strategy of giving more controls and interaction, such as students can select the instructional activities based on the levels of difficulty, it can enhance students' interest and motivation. Especially, when hypermedia and interactive contents are used, it further broadens the learning setting and enriches students' learning experiences in a student-centred learning environment (Alessi & Trollip, 2001; Phillips, 2005).

USES OF MULTIMEDIA IN EDUCATION

In recent years, multimedia has introduced the pedagogical strength in facilitating student learning and supplementing learning with liveliness as it adds richness and meaning to the information presentation with the use of more than one medium (Shank, 2005; Asthana, 2009). Multimedia involves the synchronisation of media in producing the media-rich outputs and is arranged in some chunks which are linked by the hypermedia. Students can navigate to the source of information in a shorter time, build the connections between relevant topics, and construct their knowledge by associating to the meaningful information (Hede & Hede, 2002; Parekh, 2006). It is important for students to self-adjust the time and determine the information based on individual differences, so that when individual differences can be accommodated by having alternatives in learning, students will then be engaged at a deeper level and appreciate the student-centred learning approach with more sense of participation (Alessi & Trollip (2001; Ma, O'Toole & Keppell, 2008). In addition, Alessi and Trollip (2001) found that when multiple media contents are used to present information simultaneously, students can

learn more effectively with focused attention than those who studying with separate media where attention is split. This is because human brain will have more processing loads to integrate and re-arrange all different sources of information (SEG Research, 2008). Today, the use of multimedia-based educational program is getting more popular in many areas of learning and training as it stimulates new ways in information delivery with the concerns of accessibility, reusability and individualization to fulfil the needs for different types of learners, but not just limited to conventional teaching and learning methods. However, it is challenging to produce a good courseware as the development requires more studies and planning in incorporating multimedia-enabled learning methods into the existing practices without creating unnecessary frustration in the learning process (Mishra & Sharma, 2004; Mantin & Klein, 2008).

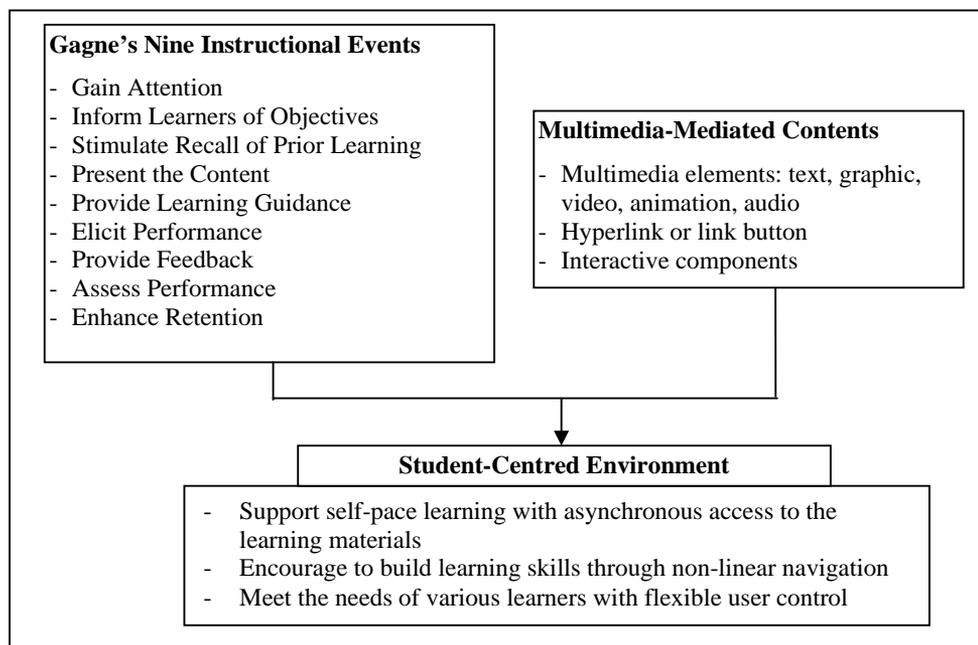## GAGNE'S MODEL OF INSTRUCTIONAL EVENTS FOR COURSEWARE DESIGN

Research shows that many e-learning programs have begun to use the instructional design theory as the development framework in guiding the design of learning contents and enhancing the quality of learning process, so that the learners' mental process and learned capability can be predicted and analysed more meaningfully (Alessi & Trollip, 2001; Martin, Klein, & Sullivan, 2004; Martin & Klein, 2008). There are a few instructional design models commonly applied for the development of educational or training program. Among them, Gagne's model of nine instructional events is one of the popular frameworks for designing learning contents, which contributed by Gagne (1985). Gagne (1977) identifies learning regards the process of growth and the best way to indicate that the learner has successfully learned is when the learner's capability has changed over a period of time and a noticeable change in performance. According to Gagne (1985), instructional events are also known as external events which can be controlled by the instructor and to support the internal learning processes, which are then controlled by learners, so effective learning processes should be facilitated by the external events. Table 1 below presents Gagne's events and the responding internal mental process.

Table 1: Association of Gagne's events and internal mental process (Gagne, Wager, Golas & Keller, 2005).

Gagne's Instructional Event	Internal Mental Process
1. Gaining Attention	- Activate the stimuli receptors
2. Informing Learners of Objectives	- Create level of learning expectation
3. Stimulating Recall of Prior Learning	- Retrieve and activate working memory
4. Presenting Content	- Perceive, recognize content and pattern
5. Providing Learner Guidance	- Rehearse and encode the knowledge to memory
6. Eliciting Performance	- Retrieve, respond and enhance encoding by responding to questions
7. Providing Feedback	- Reinforce and assess the learning performance
8. Assessing Performance	- Reinforce the content as the evaluation
9. Enhancing Retention & Transfer	- Retrieve and generalize the learned skill to the situation or case

Gagne's instructional model focuses on giving instruction but not directed for teaching, hence it covers all aspects of teaching and learning (Smith & Ragan, 2000). These events are also suitable to be applied into authoring environments that lack of proper instructional support and instructional principles (Nelson, 2000). Specifically, Gagne's instructional events can work in guiding the selection of appropriate media in the development of learning program, for better supporting the internal learning process of the learners (Gagne, 1985). The framework is also flexible as the instructor can alter the order of events based on the particular learning objective to support the needed learning processes (Martin & Klein, 2008). Since the formulation of Gagne's instructional events, many instructional technologists has incorporated his model into the development of educational research project or vocational program development (Catanese, 2008). For example, Tsai (2008) used Gagne's model in teaching the subject named 'Fog Index of Readability' to guide the students through the process of calculating the Fog Index of English Writing which has successfully enhanced the learning retention. Besides this, a radiologist, Belfield (2010) also used Gagne's model in teaching chest-x-ray interpretation for three years of learning session, she found that the instructional events make the teaching process more smoothly, whereas learners can learn effectively and be more prepared for the examination, additionally some students became more stimulated in pursuing a career of clinical radiology.

As a result, the current research design incorporates Gagne's model of nine instructional events to the development of this ILM, in which the learning contents are presented with the multimedia elements to provide more interactivity. The learning environment is also arranged based on the concept of student-centred learning to enable the learners to interact meaningfully with the learning contents and stay more focused during the learning process. The diagram below (see Figure 1) shows the details that involved in this research design.

Gagne's Nine Instructional Events

- Gain Attention
- Inform Learners of Objectives
- Stimulate Recall of Prior Learning
- Present the Content
- Provide Learning Guidance
- Elicit Performance
- Provide Feedback
- Assess Performance
- Enhance Retention

Multimedia-Mediated Contents

- Multimedia elements: text, graphic, video, animation, audio
- Hyperlink or link button
- Interactive components

Student-Centred Environment

- Support self-pace learning with asynchronous access to the learning materials
- Encourage to build learning skills through non-linear navigation
- Meet the needs of various learners with flexible user control

Figure 1: Student-Centred Environment with the Use of Multimedia and Gagne's Events.

METHODOLOGIES

Research Design

This research study comprised of IT program students as the sample participants who were selected from the multimedia classes which conducting 'Computer Graphic' topic at INTI International University. Based on some background study and academic records, all these students have some basic computing knowledge, university learning experiences, and proficient in English. However, these students were familiar with face-to-face classroom learning, but never experience learning with any web-based interactive learning program in higher education. During the learning process, the ILM was uploaded to the web server for students to access from any computer with Internet connection, hence providing a more flexible learning process to meet students' learning preference. There are three data collection instruments used in this study. Firstly, prior to learning with ILM, students' prior knowledge to the lesson was accessed by using pre-test. After students learned through the ILM, post-test which consists of same questions with randomized question sequence was conducted to identify the student learning outcomes from this learning environment. Secondly, after students experienced the learning process in this learning environment, 5-point Likert Scale questionnaires with 30 survey items was used to identify the change of student attitude by measuring the level of agree response with each survey item. The analysis of student perceptions are arranged in six categories: 1 - learner-centred environment; 2 - use of multimedia; 3 - understanding of content; 4 – motivation; 5 - content organisation; 6 - availability of feedback. Thirdly, 10 open-ended questions were set to collect students' opinion, suggestion and expression with more in-depth and meaningful details in regard to their perception on this ILM. All these qualitative and quantitative data were analysed by using mixed method research approach and specifically, combined with triangulation design to validate different sets of data and to complement each other for enhancing the completeness.

Development of ILM

The interactive learning module (ILM) was the core part of this student-centred learning environment. It is developed by incorporating Gagne's nine instructional events and multimedia-mediated content for the chapter "Computer Graphic", which is a common topic for interactive multimedia subject. In this ILM, it starts with an introductory animation, then proceed to a section named 'Refresh Your Mind' before presenting the Main Menu, which serves as 'Home' for students to navigate to the four main parts with different sub-topics. In each part, students were firstly directed to 'Objective' screen, lastly landed at 'Tutorial' and 'Review' screen. The table below presents how the instructional events were used in designing the instructional materials and activities in the ILM to facilitate students' learning. In addition, Figure 2 and Figure 3 presented the screen design of the ILM.

Table 2: Use of Gagne's nine events of instruction in developing the ILM.

| Gagne's Events, Instructional Rationales and Features in the ILM |
|---|
| **Event 1 - Gain Attention -** To grab the attention and motivate the students to start learning |
| - Short animation clip with content-related story was presented as the introductory scene.
- Content-related questions were added in the short animation clip to raise the curiosity.
- Animated images were used in the lessons to direct the student's attention. |
| **Event 2 - Inform the Learners of Objectives**
- To provide learning expectations to motivate students to complete the learning process |
| - Learning Objective section was presented at the start of each chapter.
- Students could link back to Objective section from a particular chapter through hypertext. |
| **Event 3 - Stimulate Recall of Prior Learning**
- To recall existing knowledge and correlate it to new knowledge |
| - 'Refresh Your Mind' section was presented before entering to the learning section.
- Some words in the lessons were added with hyperlinks, to allow pop-ups for more explanation, or link back to 'Refresh Your Mind' section. |
| **Event 4 - Present the Content -** To meaningfully present new contents to the students |
| - Text explanations were arranged in paragraphs and point forms.
- Extra details were available with the given hyperlinks.
- Video clip was used to present the explanation with more visual details.
- Audio was used to provide alternative, students could learn by listening to the speech. |
| **Event 5 - Provide Learner Guidance**
- To rehearse the learned knowledge to enhance students' understanding |
| - User control and instruction were provided to navigate to different parts of contents.
- Interactive activities were embedded to rehearse new learned knowledge.
- Interactive diagram were used to reveal the information sequentially. |
| **Event 6 - Elicit Performance**
- To respond to the practices and enhance the encoding of new knowledge |
| - Tutorial sections were prepared at the end of each part for self-paced practice.
- Simple activities were added in the lesson for students to test their understanding. |
| **Event 7 - Provide Feedback**
- To provide formative feedbacks to the result for practicing the new skills |
| - Provide feedbacks upon the completion of the tutorial
- These feedbacks include showing the answer provided by the student; specific guidance; and the correct answer for incorrect attempts |
| **Event 8 - Assess Performance**
- To evaluate the level of knowledge mastery for reinforcing new knowledge |
| - Performance test was given to evaluate students' performance after learning with ILM.
- Student's performance summary was presented to reveal the students results.
- Some suggestions were added according to level of achievement to motivate students. |
| **Event 9 - Enhance Retention &Transfer to the Job**
- To retrieve and generalize new learned knowledge to other course assessment |
| - Review Section was added with some short video clips for knowledge enhancement.
- Student coursework were designed and required students to apply new knowledge in the making process. |
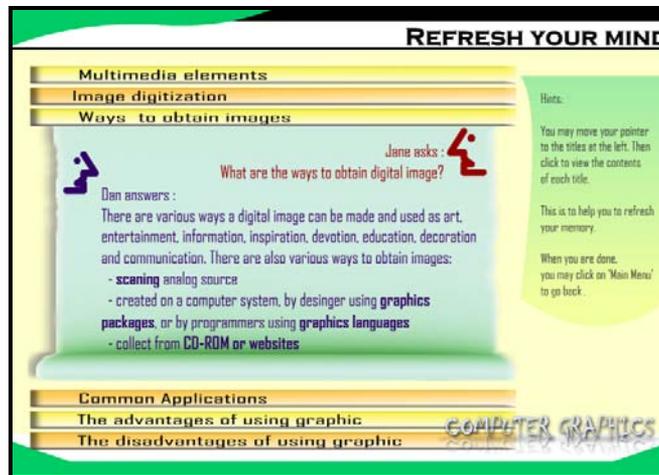
Figure 2: Screenshot of 'Refresh your Mind' in ILM to stimulate prior knowledge, Event 3 in Gagne's Model.
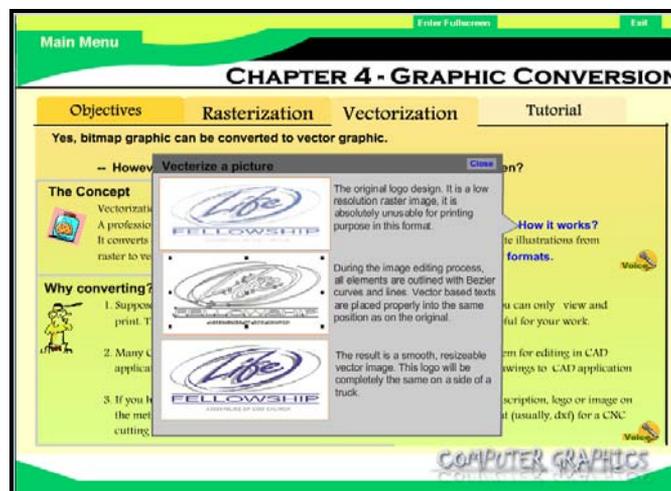

Figure 3: Screenshot of presenting learning contents with multimedia elements in ILM, Event 4 in Gagne' model.

FINDINGS

1. STUDENT LEARNING OUTCOMES

The student learning outcomes are assessed from the results of the pre-test and post-test by identifying the students' learning achievement in this learning environment.

Table 3: Mean scores and standard deviation from pre-test and post-test results

Test results (total=100)	Mean	STD
Pre-test	47.77	15.12
Post-test	63.39	11.56

Table 3 shows that the pre-test mean score (M) is 47.77 and standard deviation (STD) is 15.12, indicating that the student learning outcomes were below average as they did not have specified knowledge to answer the questions before they start learning. Later, the post-test result shows that the mean score is 63.39 and the STD is 11.56. The results suggested that students' learning outcomes was at the satisfying level as the mean score is at above-average grade. In a normality test, this sample was proved to have a normal distribution, where as in paired-samples t-test, a significant difference exists between the pre-test results and post-test results. Therefore, it is convinced that this learning environment has significantly improved student learning achievement.

2. SURVEY RESULTS AND STUDENTS' PERCEPTIONS

As the survey was proved as a very reliable survey based on Cronbach's Alpha test with the reliability score of 0.916, the student perceptions were analysed based on survey results, and these results were organized in six categories:

1. Learner-Centred Environment

The survey results show that 93.5% of students (see Table 4) agreed that ILM provides the chance for learner-centred learning, and many student prefer to have individualized learning way as they could self-direct their own learning process, student highlighted that *"...the opportunity to access the chapter, so I could study in my own pace"* and *"...it gives me enough freedom to think and learn on my own"*. There is 67.7% of students agreed that they did not face difficulty in doing the tutorials, and 71.1% students agreed that they were able to able the learning materials with no difficulty in ILM. They said: "…*tutorials can be done as many time as possible, also all the questions and options are in random mode, so I can try again and again, and identify my weakness and mistakes*" and *"I can repeat it for several times, because I have to learn slowly"*.

Table 4: Survey Results for Learner-Centred Environment

Survey Items	Mean	STD	%
1. The learning module generally gave me the chance to build up my own style and pace of learning.	4.26	.575	93.5
22. I had no problem going through the tutorials on my own.	3.87	.885	67.7
25. I was able to access the materials / resources without much difficulty.	3.77	.845	71.1
26. This module encouraged me to fully participate in every section.	3.77	.884	64.5

2. Use of Multimedia

There was 87.1% of students (see Table 5) agreed that the video clips had helped them to obtain more realistic information while 77.4% of students agreed that the use of media can deepen their understanding. These highly positive results show that the students found that media elements, like video or motion graphics can deliver more detailed information, they reported: *"I don't need to read the text so many times, the animation and pictures help me to understand"* and *"...multimedia elements help me learn faster than people teaching me"*. In addition, 80.6% of students agreed that it is adequate to use media in ILM as their memory was improved, some students said: *"...the animation and sound can attract me and I memorize better"*, *"...last review session motivates me...know how graphics are used today"* and *"...narration in the tutorial session as if my lecturer is speaking and motivating me…"*

Table 5: Survey Results for Use of Multimedia

Survey Items	Mean	STD	%
2. After watching the video clips, I got to know some similar situations in real world.	4.26	.682	87.1
3. The last review helped me to deepen my understanding of the subject matter.	4.19	.873	77.4
6. The program included enough illustrations and examples.	4.06	.772	80.6
16. I felt it is better to present the concept / information using multimedia technology (e.g. animation, narration, interactivity).	3.94	.854	77.4

3. Understanding of Content

There was 87.1% of students (see Table 6) agreed that they were benefited from learning with ILM while 83.9% of student also agreed the ways of recalling their prior knowledge are appropriate. They commented that *"...it refreshed my mind and helped me to structure the old lessons, then it will be easier to learn"* and *"I like the design in the beginning, 1 person asks and another person answers him, it is like I am asking these questions again..."* On other side, a lower percentage, 67.7% of students agreed that it was helpful for recalling the existing knowledge in a lesson however, it was recorded that many students have more demands on it, such as: *"...wish more info in previous lessons can be included, because it is not enough for me"* and *"...contents are not enough, I recommend to add more pages at here, so it can be like the revision part before the new chapter is started..."*.

Table 6: Survey Results for Understanding of Content

Survey Items	Mean	STD	%
7. This learning module always helped me to tie my own knowledge with the new knowledge in current lessons.	4.03	.657	87.1
11. The ways of recalling my own knowledge used in this learning module are appropriate.	3.97	.657	83.9
23. The 'Refresh Your Mind' section helped me much in recalling the knowledge which I had learned previously.	3.81	.749	67.7
27. I can describe the scope of each lesson before I start learning.	3.74	.729	71.0
28. I knew what I was supposed to learn before the lessons start.	3.71	.938	58.1
30. I clearly understood what was expected of me.	3.65	.798	51.6

4. Motivation

There was 77.4% of students (see Table 7) agreed that they have had good experience for learning with ILM, and 74.2% of them prefer to continue and recommend this ILM to their peer. They reported that: *"…the colours and the stuff look so lively, I think it is better than some of the learning websites…"*, *"It is like we are using the electronic book, it is very impressive to work... "*. On other hands, 83.9% of students agreed that they were motivated to learn in ILM and 74.2% of them agreed that their attention was held by the contents in ILM. The students commented that the motivation came from: *"…looking at the screen and like to pay more attention to it…"*, *"…colours used in each page…I can easily recognize the parts and not get lost…"* and *"…can feed my curiosity with many features for the topics…"*. Another 77.4% of students agreed that they realized that learning through the ILM can be more enjoyable and interesting as they were impressed by: *"…examples look realistic…"*, *"the review book can drag the thing…"* and *"…cute animated characters looks so interesting and makes me feel happy…"*

Table 7: Survey Results for Motivation

Survey Items	Mean	STD	%
4. I would enjoy using other computer-based learning modules like this one in future lessons.	4.10	.831	77.4
9. I would recommend this program to other students.	4.00	.816	74.2
10. This interactive learning module had motivated me in learning or exploring more knowledge.	3.97	.657	83.9
17. The content always held my attention.	3.94	.964	74.2
20. I found learning is interesting from this learning module.	3.90	.831	77.4

5. Content Organisation

As for the sequence of the content, 74.2% of students (see Table 8) agreed that feedback was presented timely in LIM, and 77.4% of students agreed that the learning materials are well-arranged, some comments include: "in ILM, *I know I can focus on the important part…"* and *"…information in each part is organized nicely… our learning process is much smoother…"*. With regard to content design and planning, 80.6% of students agreed that ILM has good content planning and make the lessons clearer and more understandable, they responded that the good organization is preferable: *"…arrangement of the information and some multimedia elements are good and neat…"*, *"The information is separated in different tab…we can always stay on the right place"* and *"I like the way that the information is arranged in point form, very easy for me to understand"*.

Table 8: Survey Results for Content Organisation

Survey Items	Mean	STD	%
5. The comment is always presented at the right time.	4.10	.790	74.2
8. The learning materials in this learning module are well-organized or followed a suitable sequence.	4.00	.856	77.4
18. The content was clear and easy to understand.	3.90	.746	74.2
19. Questions are planned carefully and relevant to the content of the learning module.	3.90	.746	80.6
24. The arrangement of information in each screen provided me a comfortable learning experience.	3.77	.884	71.0

6. Availability of Feedback

As for providing feedback to support learning, 77.4% of students (see Table 9) agreed that feedback from the tutorial section enhance their learning while 83.9% of students agreed that the comments from the tutorial were acceptable as these could improve their understanding: *"I can think about the mistake from the feedback...",* *"...so we can know what we did wrong and the answer...", "...explanation make me easy to understand the chapter"* and *"...I was able to judge my ability and knowledge level".* As for providing supporting examples, there was 74.2% of students agreed that the review section could strengthen their memory and they noticed that: *"...got many given in some of the page"* and *"last review can know more from examples...".* However, 64.5% of students agreed they were able to gain more confidence through the supporting materials. The high undecided percentage is believed that student expected to have more improvement to better support learning, such as students reported that: *"...no Q&A session...we could not post a question because not all information is given in the program...".*

Table 9: Survey Results for Availability of Feedback

Survey Items	Mean	STD	%
12. The feedback in the end of tutorial sessions enhances my learning process.	3.97	.657	77.4
13. The tutorials had given me enough opportunity to practice what I had learned.	3.97	.752	77.4
14. I was provided with enough information about tutorial results.	3.97	.752	77.4
15. I can accept the comment and it seems positive to me.	3.94	.629	83.9
21. The review at the end of each chapter helped me to strengthen my memory.	3.87	.806	74.2
29. Those supporting examples give me confidence in learning.	3.68	.748	64.5

DISCUSSION

In this study, the methodology was designed to enhance the quality of learning, which comes with three emphases: Gagne's model of instructional events, multimedia elements and student-centred learning. This study aims at answering the research question, and forming a useful framework to propose a systematic guide on improving the quality of student learning and enriching the student-centred learning experience. As for answering research question "What are the impacts of Multimedia-Mediated Student-Centred Learning Environment (MMSLE) on student learning", six important impacts were identified based on the results and analysis obtained from this study.

1. Multimedia-mediated content serves as important components in learning

The use of multimedia elements in creating the learning contents makes the learning experiences more meaningful. It becomes an important component in learning as it provides the students with an alternative means to have more choices when learning in the student centred learning environment. The learning attitudes changed as the students realised that learning with multimedia elements was more flexible in exploring and constructing new knowledge. This has engaged the students and boosted their learning interest in this student-centred environment.

2. Gagne's nine instructional events were a proper and sound pedagogy to use

Although over the years Gagne's instructional model has proven to be effective in different learning and training aspects, this study again proves that Gagne's model provides a proper and sound pedagogy to use in guiding the design of learning content for a student-centred learning environment. Besides, it also shows this model can flexibly accommodate the use of multimedia elements in presenting the information with non-linearity manner.

3. Student's retention and learning outcomes were improved

The increase of mean score (from 47.77, in the pre-test to 63.39, in the post-test) displayed a statistically significant difference in students' learning outcomes, which suggested that the majority of students progressed towards better learning outcomes This improvement shows when media-rich approach and systematic approach are employed in the development for assisting students learning , students' learning outcomes and their retention can be improved.

4. Student-centred learning approach was suitable for classroom learning environment

In this study, student-centred learning approach was used to focus on student's needs and interests to strengthen their motivation with more control in the learning process. It shows that with the encouragement, students were able to make full use of the learning program and benefit from the features in self-directing their learning process, and hence making the classroom learning experience more meaningful and feasible for different students.

5. Students became more engaged and self-directed learners

The change of students' learning attitude also came from engaging students in the learning process and being able to interact with the ILM. As more retention can be reinforced, the students become more engaged to the learning environment. Hence, students are transformed into a self-directed learner and become pro-active towards his or her entire learning process.

6. A framework for interactive multimedia learning was developed to effectively enhance student learning in a Malaysian university classroom

Based on the results in this study, a framework for effective interactive learning with multimedia was successfully developed to address and respond to the limitations of the teacher-led learning environment where the students were restricted from having a flexible learning process (see Figure 4). In this multimedia-mediated student-centred learning environment (MMSLE) framework, a sound pedagogy such as Gagne's 9 Events were effectively incorporated to provide students with interactive learning materials that engaged them and enhanced their learning process. This framework presents the combination of various components, with the ILM at the core of the learning environment and can serve as a guide to provide Malaysian academicians in higher education with a more practical alternative to move from the conventional approach of classroom teaching and learning in Malaysian classrooms.

Multimedia-Mediated Student-Centred Learning Environment (MMSLE)

Gagne's Model of Nine Instructional Events

Incorporated

Multimedia-Mediated Contents & Hypermedia

Student-Centred Environment

Web-Based Access
- Asynchronous access to deliver the learning contents
- Non-linear styles for self-paced navigation
- User control for features & screen interface

Interactive Learning Module (ILM)
It contains various features & flexible access:
- Introductory Scene, Stimulate Prior Knowledge
- Learning Objective & Learning Content
- Learner Guidance & Instructions
- Tutorial Question & Response & Review

Students' Perceptions on the ILM
1. Students were motivated & engaged while learning through ILM
2. Students' confidence increased with support in learning
3. Students' understanding was improved with multimedia-mediated content
4. Students preferred to learning from media-rich content
5. Students' learning experience was enhanced by good content arrangement
6. Students enjoyed learning at own pace
7. Students at INTI were positive to the ILM

Impact on Student Learning
1. Multimedia-mediated content serves as important components in Learning
2. Gagne's nine instructional events were a proper & sound pedagogy to use
3. Student's retention and learning outcomes were improved Students
4. Student-centred learning approach was suitable for classroom learning environment
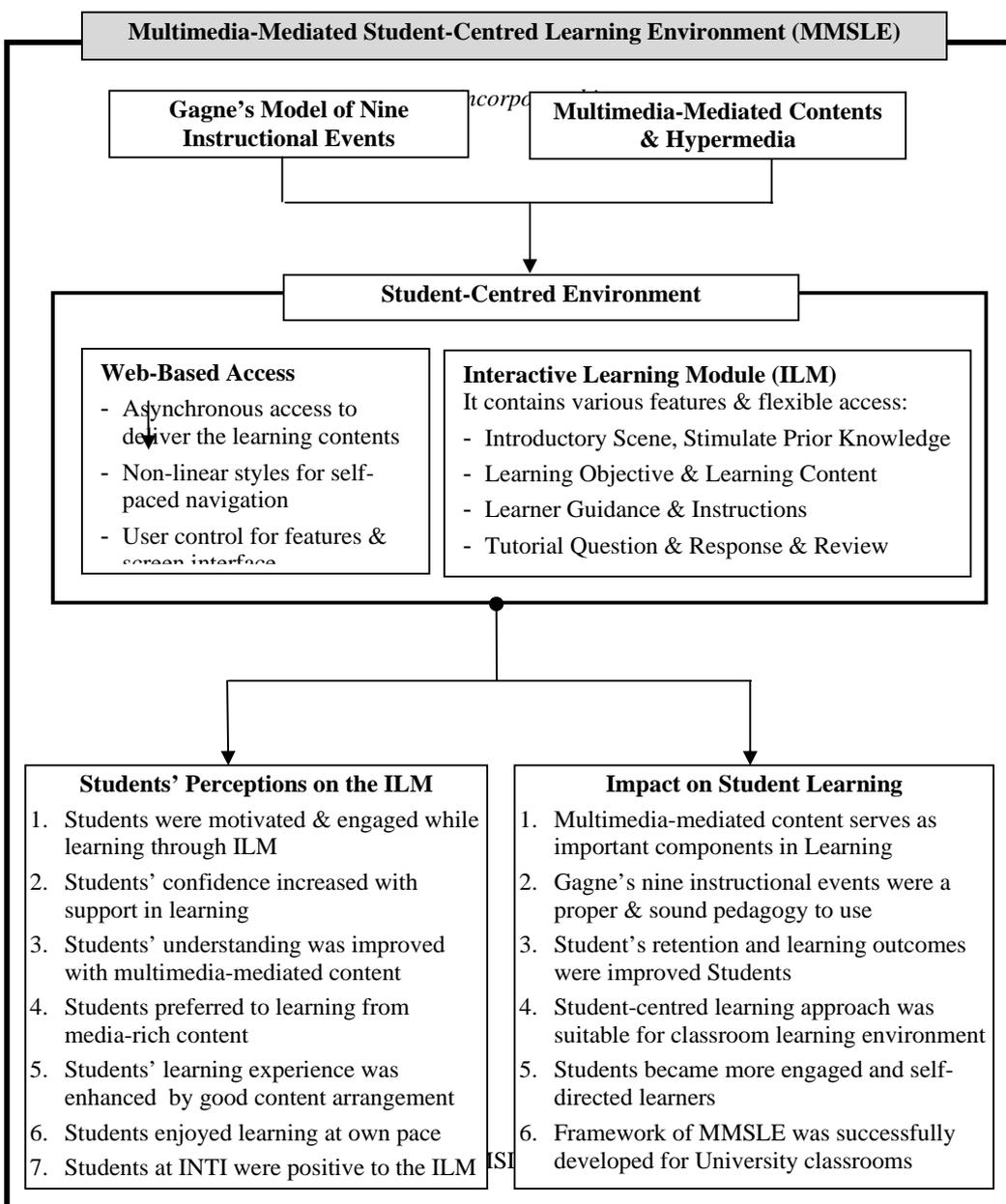5. Students became more engaged and self-directed learners
6. Framework of MMSLE was successfully developed for University classrooms

CONCLUSION

Based on the research design and analysed results from this study, the research results were consistent with the literature review, where development of the Gagne-based ILM fulfilled the needs of supporting active learning and providing flexibility to enhance the quality for student learning in University classroom. In addition, a multimedia-mediated student-centred learning environment (MMSLE) framework was developed as a guideline for educators in higher institutions to employ. The framework proposed the incorporation of a sound instructional model, creative media content, embedded in a student-centred learning environment, in order to engage and motivate students in their learning process.

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