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Engaging students in multimedia-mediated Constructivist learning – Students' perceptions

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ABSTRACT

This study was conducted in the Faculty of Creative Multimedia, Multimedia University, Malaysia and investigated students' perceptions while working on a multimedia project that was embedded within a constructivist-based learning environment. We studied the impact of using multimedia on students who have little experience with working in a problem-solving design environment. Students worked in groups and created an interactive multimedia application with Macromedia Director. They were responsible for all project development decisions during their learning process. A survey questionnaire administered at the end of the project captured their perceptions. The students showed positive attitudes towards the project with respect to their learning motivation and understanding, skills and their teamwork abilities. By incorporating multimedia into a constructivist learning environment, students learned to design multimedia, as well as to experience critical-thinking, creative, presentation and communication skills; enhanced motivation and understanding various levels of the subject domain. These skills would all be useful in their future undertakings. Our findings provide strong support and encouragement for Malaysian educators to incorporate multimedia technology and constructivist learning into the classrooms for the enhancement of teaching and learning.

Keywords

Constructivist learning, Multimedia projects, Student perceptions, Malaysian perspective, Multimedia authoring

Introduction

The infusion of Information Communication Technology (ICT) and, in particular, multimedia technology into education has created a significant impact on the instructional content development and the methods of communicating information to learners. This leads to the evolution of new concepts and innovative teaching techniques in the instruction-learning process, changing the way teachers teach and students learn. This changing landscape of education focuses on learning, rather than on teaching and pedagogy, curriculum and instruction. It seeks to create a generation of learners whose learning is defined as *"the ability to retain, synthesize, and apply conceptually complex information in meaningful ways"* (Lambert & McCombs, 1998). It also encourages better student learning through the learning objectives of project-based learning, or learning by doing (Schank, Berman and Macpherson, 1999), and to enable problem-solving, analysis, creativity and communication to take place in the classroom (Bates, 2000). In addition to these, multimedia technology has been shown to affect students' motivation and self-esteem levels, as well as allow them to become creative and self-directed thinkers (Agnew, Kellerman & Meyer, 1996).

In Malaysia, the traditional mode of learning is used in many institutions of learning. However, in the context of introducing technology and multimedia in learning, the Malaysian Government is echoing this learner-centred learning initiative with a call for Malaysian institutions of higher learning to integrate ICT into their classrooms (Mat, 2000). In addition, there is a strong push by the Malaysian Government to develop creativity, communications skills, analytical and critical thinking, and problem-solving skills — skills that are significantly lacking in current graduates (Tan, 2000; Teo & Wong, 2000). This mismatch has prompted Malaysian educators to seek new ways to develop these appropriate skills and knowledge in students in order to meet the rising expectations of the knowledge society. World-wide research, as well as in Malaysia, has shown that using constructivism and multimedia technology has becoming increasingly important in teaching and learning in higher education in order to promote and enhance the teaching and learning process (Shaziti 2000; Wong, Kamariah & Tang, 2003) when set within authentic contexts (Herrington, Reeves, Oliver & Woo, 2004),. This enables teachers to better transfer knowledge to their students in the classrooms (Wong et. al, 2003).

In the past, in the Malaysian region, many research studies tested ready-made CAI multimedia courseware on students (Norhayati & Siew, 2004; Mishra & Yadav, 2006), as well as the development of multimedia courseware by

educators for teaching purposes (Rozhan & Habibah, 2000; Suraya 2005). Research on constructivist learning environments and problem-solving activities have been confined to Internet-based learning environments where students' perceptions of using Web-based learning materials were investigated (Low, Low & Koo, 2003; Lee & Tsai, 2005). The focus was to produce graduates with critical and creative thinking skills, oral and written presentation skills, and active learning skills. However, more focus should be placed on learning with ICT and multimedia technology within authentic, project-based, collaborative and multimedia-mediated learning environments.

This study was thus designed to investigate students' perceptions in using a multimedia project that was embedded within a constructivist-based learning environment and to study the impact of using a multimedia project on students with little experience with working in a problem-solving environment. Students in a second-year multimedia course worked in groups to develop an interactive multimedia application using a high-end multimedia authoring tool, Macromedia Director. The students all played active roles in their project development processes, as well as in determining and reaching their learning goals. In this context, the focus was on the learning process rather than on the content: learning "how to learn" rather than on "how much is learned". In this learning environment where technology was integral to their learning, the students develop critical thinking skills, problem-solving and team skills, experiential learning and inter-disciplinary knowledge (Oliver, 2000). This represented a move away from the traditional modes of tuition to one where the learners became active participants in the learning process (Oliver, 1998).

This study was intended to show that, through their perceptions and feedback on the project, the students would be able to reveal their ability to acquire skills integral to the demands of the workplace relevance: skills such as collaborative and teamwork, problem-solving, learning motivation, and critical thinking and understanding of a topic area.

The constructivist-based learning environment

Wilson (1995) defines a constructivist learning environment as *"a place where learners may work together and support each other as they use a variety of tools and information resources in their pursuit of learning goals and problem-solving activities."* It is an environment that allows for learner-centred activities to take place where the teacher provides the students with experiences that allow them to develop problem-solving, critical-thinking and creative skills, and apply them in a meaningful manner. Here students work collaboratively to determine their learning goals, set their learning paths to reach their learning goals and monitor their own progress. The teacher is no longer perceived as the sole authority, but as the facilitator of learning, guiding and supporting learners in the process of constructing knowledge. Constructivism entails a strong belief that learning is a personal interpretation of the world; and that learners create interpretations of the world based on their past and current experiences and interpretations (Wilson, 1995; Jonassen 1994; Duffy & Cunningham, 1996; Jonassen & Henning, 1999). During constructivist learning, the emphasis is on learning and on the student-centric the learning environment. Students become active participants in their own learning processes and also learn to solve problems and work collaboratively.

Jonassen (1991, 1994, 1999) believes that constructivist learning environments can be designed to provide learners with meaningful, interesting and relevant problems to solve. Constructivist learning environments also demand a meaningful and authentic context for social and collaborative activities. Peers play an important role in encouraging learning, while supporting each other in a project-based curriculum as an innovative teaching and learning environment. In such an environment, students are engaged in their own learning process and become active learners. Jonassen (1999) proposed that the following components should be incorporated when designing a constructivist learning environment:

- **Conception of the problem**. A problem must first be conceived in order for the students to begin their learning development.
- **Interpretation**. Students interpret and develop solutions to their problems.
- **Information sources to support the understanding of the problem**. The learning environment provides the information that learners need to understand and solve problems. Appropriate information (text documents, graphics, sound, video and animation resources) can be accessed through the World Wide Web.
- **Cognitive tools.** Learners interpret and manipulate aspects of the problem through the World Wide Web as a cognitive tool.

- **Conversation and collaboration tools.** Learners form communities to negotiate and co-construct meaning for the problem through these tools. Students require a platform to share and exchange their ideas and create a community to solve their problem collaboratively and to facilitate and foster communities of learners. Examples are of collaborative tools are: email, chat, listserves, BBS (Bulletin Board Service), MUDs (Multi-user Dimensions), or MOOs (MUDs object-oriented).

Jonassen (1999) posited that an essential part of the learning problem is that it has to be interesting, engaging and appealing. It must also be authentic, personally relevant, challenging and interesting to learners, and provide a physical simulation of the real-world task environment. In addition, by collaborating with one another, students are exposed to multiple perspectives to their learning problems, enabling them to consider "*…varying and discrepant points of view with which to consider the merits of his or her own mental models"* (Oliver, 2000). In such an activity, student-centred learning can be cultivated because the students will engage in collaborative activities with their team members, as well as with the instructor, who acts as a facilitator and guide. Through working in groups, students will have to tap into their group's skills and use a variety of activities to accomplish the overall project objectives. The group would be responsible for their goals and, thus, a collaborative learning experience can be gained.

Jonassen's (1999) framework for designing a constructivist learning environment is adapted for this study in order to design the learning environment, and a multimedia project is embedded into this environment to form the core learning problem of the study, through which students will be able to become active participants in their learning processes and develop skills that would allow them to think critically, function as a team, develop collaborative abilities and deepen their understanding of their task, and improve their learning.

The student learning process

The study consists of of 53 students (N=53) in their second year of study. They comprised of students from the Faculty of Management, the Faculty of Information Technology and the Faculty of Engineering and were all enrolled for the Interactive Multimedia course. The objective of this course was to imbue students with multimedia project development skills over a 14-week trimester that culminated in an interactive group project that was multimedia and authored in Macromedia Director.

The learning outcome

The learning outcomes of the study were in the form of the students' final interactive multimedia applications. These learning outcomes were evidence of their learning, as posited by Winnips and McLoughlin (2001). Students completed their final applications on time and presented them at the end of the trimester. These applications ranged from edutainment to the marketing of corporate applications, centred around the theme, "*Malaysian Culture*". The applications demonstrated multiple solutions and perspectives of a learning problem. Figure 1 shows an example of a group's application, an edutainment presentation of Hang Tuah, a legendary figure in Malaysian history. Figure 2 shows an example of the Malaysian martial arts, Silat. Both applications target children, but with different approaches.

In the Hang Tuah application (Figure 1), the group used a storytelling approach for their application, teaching children about the legendary figure through presentation and additional activities to support their learning process. After the initial splash screen (Image 1) of this application, the Menu page (Image 1) presents to the users the option to read the story ("Tell Me", Image 3), or proceed to test their knowledge on the story via a quiz ("Test Me" and "Know Me"); a game ("Scramble Me"), a spelling contest ("Spell Me") or a treasure hunt ("Find Me") activity. Throughout the entire application, the interface is kept consistent with changes in background colour that depicts the various sections of the application that the user engages in.

Another group chose a more informational approach (Figure 2) to present their application, using an interactive room as their Menu (Image 1). Users can click to access various topics to access the various interactive areas. For example, if users click on the "General Info" image in the Menu, they will be presented with general information about the sport with embedded hyperlinks to keywords and definitions (Image 2). Similarly, users could view video clips on the performance of the sport ("Videos") to get a more realistic presentation of activity. Users can also choose to test their knowledge on the sport by clicking on the "Quiz" component on the Menu and be asked questions on Silat

(Image 3). From these representations, it is clear that students were able to demonstrate multiple perspectives and solutions to their design problems in line with the constructivist pedagogy (Jonassen 1994; Herrington et. al, 2004). By looking at the different approaches followed by the various groups in their applications, students were able to construct new knowledge on their own, resulting in an improved learning experience. Furthermore, the overall performance of the groups was good, as the students achieved mostly A's and B's for their projects.

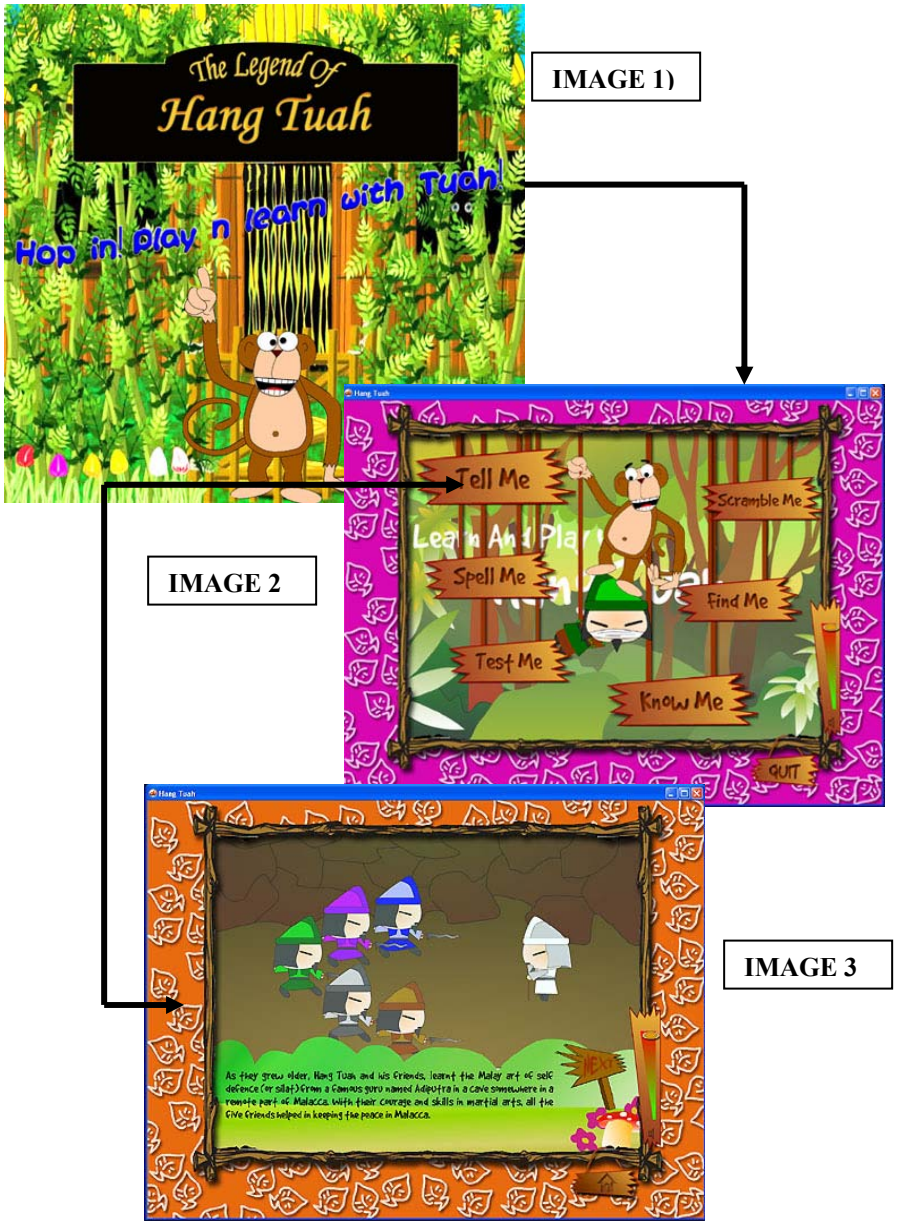

Figure 1. A storytelling approach on Hang Tuah

The students followed a 6-step learning process (Jonassen 1999) to complete these assignments to develop the multimedia project.

1. Group formation

At the start of the project, students divided themselves into groups of 4-5 members and selected a group leader for each group. The decision of their group's name, their leader and group tasks was taken collectively.

Figure 2. An informational approach on Silat

2. Problem identification

Groups discussed the problem and proposed multiple ideas for discussion. They brainstormed amongst and reached consensus for their final application.

3. Project conceptualisation

Group ideas were translated into concepts and storyboards. Members created sketches for the interfaces of their application's screen and started to acquire the necessary media elements (e.g., graphics, sound, video, animation, and text) and created the visuals for their Director application.

4. Project authoring

The final application was authored. Each member of the team was responsible for at least one screen of the application. They proceeded to develop the application collectively and collaboratively.

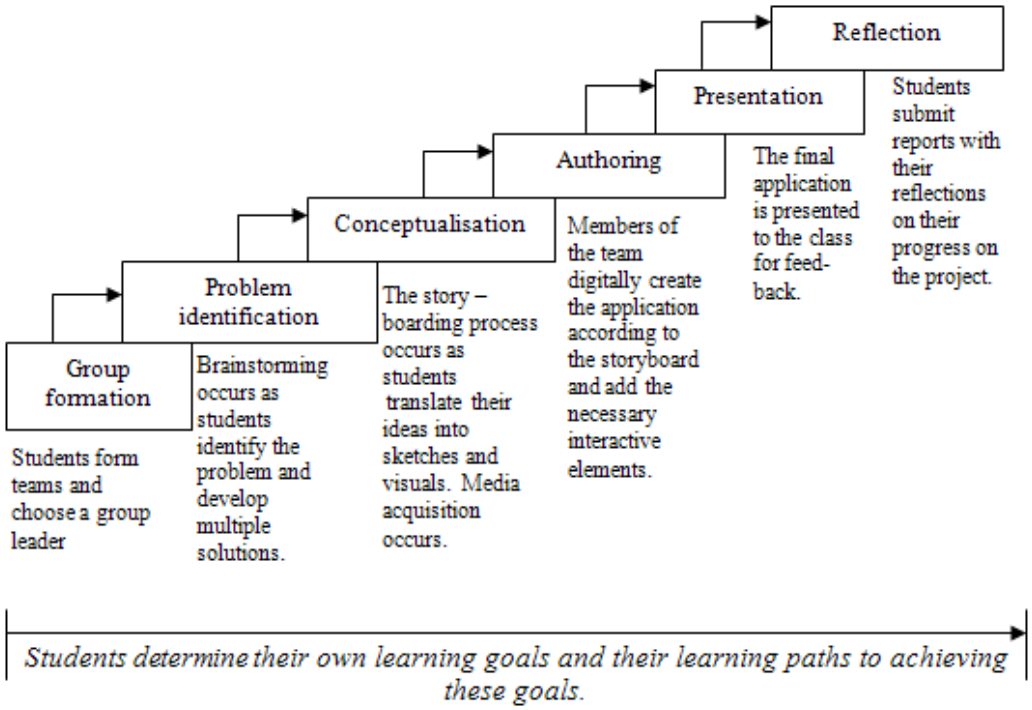

Figure 3. The multimedia-mediated student development learning process

5. Presentation

The groups made two presentations. The first was a work-in-progress presentation to give the class an overview of their work and solicit their comments. This provided them with preliminary experiences in presenting to an audience. They fine-tunee their work, taking into account the comments from other students regarding their design, navigation, interactivity and overall presentation. The second presentation was more formal on completion of the applications. The students presented their work, discussed modifications made on their first presentation, and submitted their application to the lecturer.

6. Reflection

Students reflected on: their own individual progress, their relationships with the group, the team leader, the problems they encountered individually and collectively, how they overcame their problems, as well as on the comments made by the other groups on their presentations. These reflections were incorporated in their final group report and submitted to the lecturer.

The conceptual framework of their multimedia-mediated development process is illustrated below in Figure 3.

Methodology

At the end of the project, students were given a thirty-item survey, to measure their attitudes towards developing a multimedia project in their learning process, to fill out. The survey was adapted from Diamond (1998) and Irani (1998). The items measured on a 5-point Likert scale, and with 1 = Strongly Disagree, 2 = Disagree, 3 = Undecided, 4 =Agree and 5 = Strongly Agree. The survey aimed to gauge their motivation, critical-thinking and creativity skills, teamwork, presentation and communication skills, and overall attitudes towards learning with multimedia and developing a multimedia project.

Results

The collected data were analysed with SPSS version 11.5, and yielded a Cronbach Alpha coefficient of 0.9106, which satisfies the requirement of survey reliability (Lim, Khine, Hew, Wong, Shanti & Lim, 2003). Results showed that students had very positive attitudes towards the project and their use of multimedia technology in this learning environment. From their responses from the survey, open-ended questions and the interviews, students' perceptions toward this study can be categorized into the following areas:

- Learning motivation
- Increased understanding and learning of subject domain
- Skills and real-world relevance
- Teamwork and collaboration

Tables 1-4 present the results of the questionnaire in the 4 areas, with the overall means (m) ranked for each items in these 4 areas, the percentage of responses (p) by students according to the 5-point Likert scale (i.e., SA = Strongly Agree, A= Agree, U = Undecided, D = Disagree, and SDA = Strongly Disagree) as well as their respective standard deviations (SD). In addition, student comments and feedback were also obtained from their journal reports and from the survey's open-ended question section. Students provided feedback on their learning process as a result of doing this interactive multimedia project, which are also show in Tables 1-4 accordingly.

Table 1. Results for students' learning motivation

Learning motivation **Items in the survey**	**mean**	**SA (p)**	**A (p)**	**U (p)**	**D (p)**	**SDA (p)**	**SD**
1. Motivated to do project	4.25	30.2	64.2	5.7	0	0	0.55
2. Project made me want to do my best	4.25	32.1	60.4	7.5	0	0	0.59
3. I found the project to be challenging yet stimulating to do	4.19	30.2	58.5	11.3	0	0	0.62
4. I enjoyed working on a project like this	4.08	24.5	62.3	11.3	0	1.9	0.73
5. This course has given me confidence in my newly acquired skills	3.91	18.9	56.6	20.8	3.8	0	0.74
6. I was able to maintain contact with my lecturer	3.74	7.5	62.3	26.4	3.8	0	0.65
7. I am very satisfied with my contribution to the project	3.68	17.0	41.5	34.0	7.5	0	0.85
N=53							
Students' comments on Learning Motivation: 1. *"Very motivated. This subject is very fun. I get the chance to come out with my own ideas and creation on an application."* 2. *"I feel motivated from that cause I can learn some new skills that I can't learn from my faculty".* 3. *"I am so happy and motivated when do this project."*							

Learning motivation

From Table 2, it can be seen that students' motivation levels were high and their interest in doing the project was very much enhanced, as the three highest ranked items in the survey were motivation items. In particular, students felt highly motivated in completing their projects, and reported that the project encouraged them to work hard. Most students (94.3%) reported favourable motivation levels (m=4.25) and 92.5% of students reporting that the project made them do their best (m=4.25), making these two items the highest ranking items in the survey. They also indicated that although the project was challenging, it provided much stimulation in their learning process -- 88.7%

reporting in favour of the item (m = 4.19). Almost everyone in the class reported that they enjoyed working on such a project (m = 4.08, p = 98.1), whereas 75.5% of students reported that doing the project has given them confidence in the skills which they had acquired in the process (m = 3.91), and 69.8% were able to maintain contact with their lecturer during the project development period (m = 3.74). And as such, 92.5% of students reported that they were, on the overall, satisfied with their contribution to the project (m = 3.66).

Support for this favourable report can also be seen in their comments and feedback. Students reported that they enjoyed doing the project as it made them feel very motivated and satisfied with their contributions. Students reported in their journals (Table 1) that they were motivated because the project was something that was relevant to them and elicited their curiosity. They also expressed excitement with the innovative way information was presented as they used multimedia technologies to create something that was digital and interactive.

Increased understanding and learning of subject domain

This construct was incorporated to gauge students' perceptions on whether doing the project resulted in an increased level of understanding for the subject matter and on their own learning process (Table 2).

Table 2. Results for students' understanding of the subject domain

Increased understanding **Items in the survey**	**mean**	**SA (%)**	**A (%)**	**U (%)**	**D (%)**	**SDA (%)**	**SD**
1. The project enhanced my learning of interactive multimedia	4.13	26.4	62.3	9.4	1.9	0	0.65
2. The project increased my understanding on how to manage and develop an interactive project	4.13	24.5	67.9	3.8	3.8	0	0.65
3. I am now a better learner	4.02	20.8	64.2	11.3	0	0	0.69
N=53							
Students' comments on Increased Understanding: 1. *"Before doing this project, I do not know much about Silat…but after working on this topic for past four months, I learnt Silat in detail. Now I am able to explain about Silat to my other friends".* 2. *"I believe my understanding towards interactive multimedia has vastly improved after undergoing the project given to us."* 3. *"It helps me more understand the subjects in multimedia."*							

Results in Table 2 showed that students were favourable toward this construct. In the survey, students reported that in terms of their overall understanding of the project's objective, 88.7% of students reported that the project enhanced their learning of interactive multimedia (m = 4.13) and that the project increased their understanding of how to manage and develop and interactive multimedia application (m = 4.13, p = 92.5). They also reported that they have now become better learners, (m=4.02, p=84.9). Again, these perceptions are well supported by their comments and feedback, which showed that students did perceive themselves to have increased understanding of the subject matter from the project. Many reported that they now understood what it meant to develop a project and that hands-on experience made them understand interactive multimedia development as well as on their chosen topic.

Skills and real-world relevance

This construct was to gauge students' attitudes and perceptions on their acquisition and experience with skills such as critical-thinking and creativity skills, teamwork and group skills, communication and presentation skills, multimedia technology skills, and the ability to properly apply them (Table 3).

Results from their survey shed more light and support for this construct, as, in terms of acquired skills, 88.7% of students reported that they were now able to apply their skills in a more effective manner on future projects (m = 4.15), making it the highest ranking item in this category. They also reported being able to analyse, synthesise, and evaluate information (m = 4.08, p = 88.7). Critical-thinking skills were also enhanced, as 79.2% of students reported that they were now able to think critically about developing interactive multimedia applications, (m=3.94), as were presentation and communications skills, as 67.9% of students reported that the project allowed them to improve their

presentation skills (m = 3.72), and presenting their project well using multimedia (m=3.89, p=75.5). Students also showed increased perception of the relationship between their work and the work in real-life situations. 84.9% of students reported that after completing their project, they were now able to see the relevance between the project's task and the course, with real-world situations (m = 4.04), allowing them to develop skills needed in the real-world (m = 3.98, p = 81.1).

Table 3. Results for students' skills acquisition

Skills and real-world relevance **Items in the survey**	**mean**	**SA (%)**	**A (%)**	**U (%)**	**D (%)**	**SDA (%)**	**SD**
1. I am now able to apply my skills in a more effective manner on future projects	4.15	26.4	62.3	11.3	0	0	0.60
2. The project allowed me to analyse, synthesise and evaluate information	4.08	18.9	69.8	11.3	0	0	0.55
3. I saw the relevance between the course and real world situations	4.04	22.6	62.3	11.3	3.8	0	0.71
4.This project allows me to develop skills needed in the real-world	3.98	18.9	62.3	17.0	1.9	0	0.66
5. I am now able to think critically about developing interactive applications	3.94	17.0	62.3	18.9	1.9	0	0.66
6. We were able to present our project well using multimedia	3.89	18.9	56.6	20.8	1.9	1.9	0.80
7. The project allowed me to develop and improve my presentation skills	3.72	7.5	60.4	28.3	3.8	0	0.66
N=53							
Students' comments on Skills and Real-World Relevance: 1. *"...from the experience of working with my group members, I am prepared to face different people I might meet in the near future."* 2. "I get to know more about how to develop a good project in the future as if I have the chances to take on the multimedia task." 3. *"I learnt a lot of skills and knowledge…which enable me to understand and may apply to my future as well."*							

Students' comments and feedback further provided support to the results and showed that they were able to acquire and experience these skills and that they saw the relevance of these skills with that needed in the real-world. They also reported that the acquisition and experience of these skills increased their confidence levels in solving project- and team-related problems in the future (Table 3).

Teamwork and collaboration

The final construct in this study was to gauge students' perception and attitudes towards working in a team and collaborating with their group members (Table 4).

This teamwork construct was well supported in the survey results as many students reported favourably on many of the teamwork items. In particular, 77.4% of students reported being able to get to know their team members well from doing this project (m = 3.94), 73.6% reported that they enjoyed working in a team (m = 3.83), 66% of students reported that they were able to interact well with their teammates (m = 3.66), 67.9% of students reported that they were able to contribute creative ideas in the group (m=3.75), that their group helped them to do their best in the project (m =3.72, p = 62.3%) and they were able to work well together to present their project (m-3.72, p=64.2). Problem-solving and conflict management within the team was also an item with was positively reported, as 73.6% of students reported that their group was able to solve their problems and conflicts in a positive manner (m = 3.77), and were supportive of each member's problems and tried to help resolve them (m = 3.75, p = 67.9).

Table 4. Results for students' teamwork and collaboration skills

Teamwork and collaboration **Items in the survey**	**mean**	**SA (%)**	**A (%)**	**U (%)**	**D (%)**	**SDA (%)**	**SD**
A. Team collaboration							
1. I got to know my group members well	3.94	24.5	52.8	15.1	7.5	0	0.84
2. I enjoy working in a team	3.83	26.4	47.2	15.1	5.7	5.7	1.07
3. My group was able to solve our problems and conflicts in a positive manner	3.77	15.1	58.5	18.9	3.8	3.8	0.89
4. We were able to contribute our creative ideas in the group	3.75	24.5	43.4	17.0	13.2	1.9	1.04
5. My group was supportive of member's problems and helped resolved them	3.75	20.8	47.2	20.8	9.4	1.9	0.96
6. My group helped me do my best in the project	3.72	28.3	34.0	22.6	11.3	3.8	1.12
7. My group worked well together to present our project	3.72	20.8	43.4	22.6	13.2	0	0.95
8. I was able to interact well with my classmates	3.66	11.3	54.7	24.5	7.5	1.9	0.85
B. Team dynamics							
9. Our group encouraged positive contributions from each member	3.60	18.9	45.3	20.8	7.5	7.5	1.12
10. We were able to complete our tasks on time	3.51	13.2	41.5	32.1	9.4	3.8	0.97
11. There was a lot of unity in my group	3.51	17.0	37.7	30.2	9.4	5.7	1.07
12. We were able to organise our work effectively	3.36	9.4	35.8	41.5	7.5	5.7	0.96
13. My group was able to make and follow a set agenda	3.34	7.5	35.8	39.6	17.0	0	0.85
N=53							
Students' comments on Teamwork and Collaboration 1. *"We can share out our ideas together and discuss everything together."* 2. *"Great! My group member is really good as we came from different faculty….we really work as a team especially when I face problems, my group member will always give me a hand."* 3. *"Can't be denying that, sometimes we do have argument on certain idea, but we will find a positive manner to settle it."* 4. *"I have learnt how to work in group, improve myself in working with someone new…"*							

Interestingly, 64.2% of students reported that their group encouraged positive contributions from each member (m= 3.60). Only 54.7% reported being able to complete their tasks on time (m=3.51), and 54.7% reporting that there was unity in the group (m= 3.51). In addition to that, only 45.3% of students reported being able to organise their work effectively (m=3.36) and only 43.4% reported that their group was able to make and follow a set agenda (m=3.34). This clearly shows that working as a group was a challenging task for these students and many were experiencing several obstacles to group management and group collaboration. This was also reiterated when asked for their comments. Many students reported that the biggest challenges to them were in having to solve the conflicting ideas of the groups, and the lack of time due to conflicting schedules. These problems did affect their motivation levels at times, but they managed to solve these problems through the ability to communicate using Web and telecommunication tools (that helped solve their communication problems), and by increasing their group efforts to solve their conflicts in ideas, as reported in the following comments:

1. "The most serious problem here is idea conflict among members… In order to solve this problem, we have record down each member unsatisfied problem in a paper and solve it one by one."
2. "…we also spend some time to figure out each member ideas and vote for the best idea that most people prefer."
3. ….we had faced problems especially communication problem…
4. We had problems such as dividing the workload among us since we hardly knew each other that time and most of us lived outside the campus premise…
5. As it reaches the middle of the current progress of the project, all members started to tense out and the motivation level within myself began dropping but as when it goes on doing, each one of us give and help each other to give encouragement and this makes everyone to boost up their confidence and courage to go on complete all.

6. Can't be denying that, sometimes we do have argument on certain idea, but we will find a positive manner to settle it.
7. The project was a good start at first but as it progress, we had some problems lie we stuck onto how is it going to implement to do in the application …For this, we might need some advices and lesson from other people to help us in completing through this project to be handled up on time.
8. It has been a lot of difficulty when we have trouble to find some information about the content and have one of our group members did not cooperate well but we manage to solve it wisely when we define, analyze, identify the problem and we decide what is the best solution.

From these comments, it can be seen that there were some serious hardships and challenges to the students with respect to their group work, which affected their motivation levels during the project's development. However, by being able to solve their group problems, students were able to comment favourably on their overall attitudes toward teamwork at the end of the project development. Students reported that teamwork and group collaboration were indeed important to the success of the project, that they enjoyed working in a team and found the project a good opportunity to enhance their creativity and to share their workload in the project, and were happy that they did not give up in the middle of the project.

Discussion

The results show strong support for using a multimedia project in a constructivist-based learning environment. From the survey and their feedback, students' demonstrated positive attitudes and perceptions t*o developing a multimedia project within* this learning environment. They were able to reveal that they had acquired several key constructivist learning skills *through doing the project*, which would enable them to become better skilled workers in the IT industry in Malaysia.

Specifically, the development of this multimedia project within this learning environment allowed students to experience the following:

1. In this constructivist-based learning environment using multimedia, it can be seen that students experienced high levels of motivation and self-esteem when doing the multimedia project as shown in their comments and survey results, and is in line with Reeves' (1998) perspective that, "*multimedia can stimulate more than one sense at a time, and in doing so, may be more attention-getting and attention-holding."*. More importantly, it enhanced their confidence levels in their newly acquired skills, knowing that they can use the same skills in their future undertakings.
2. Students showed increased understanding of the topic and being able to see the relevance of the project to real-life situations. This falls within the realm of authentic learning (Herrington et. al, 2004).
3. Students learnt that teamwork and collaboration became important factors to the successful completion of the project. As they had experienced difficulties in some of their group activities, students reported having had to learn about the importance of teamwork and cooperation, and to develop group and leadership skills. Although group management and teamwork were positively reported on the overall, students reported that they were still challenging skills to acquire and balance. As such this study was able to demonstrate that a technology-enhanced constructivist learning environment, as suggested by Jonassen (1994, 1999), and specifically through the incorporation of an interactive multimedia project, can be successful in allowing students to engage in meaningful, relevant problem-solving activities, experience active learning, and be more engaged in their learning process. This is in line with Herrington et. al's (2004) position and with Winnips and McLoughlin's (2001) position that the creation of applications is proof of student learning. As such, this constructivist learning environment has been successful in supporting project-based learning as an alternative to traditional classroom curriculum.
4. Multimedia technology was successfully integrated in this constructivist learning environment as an enabler and catalyst to support the students in successfully using the tools to demonstrate their creativity and problem-solving skills. By incorporating multimedia into this constructivist learning environment via their multimedia project, students were able to design using multimedia and experience critical-thinking, creative, presentation and communication skills, as well as enhancing their motivation and understanding levels. Using various combinations of media elements to illustrate their messages in the application gave students the opportunity to think critically about their messages and the flexibility to present them. Using Web communication tools also

gave them the opportunity to solve group meeting problems and to conduct any meetings or discussions, and any exchange of ideas amongst themselves whenever they had scheduling conflicts for face-to-face meetings.

5. Results of this research study provide good evidence for using multimedia technology and a project-based learning approach within a constructivist learning environment, as adapted from Jonassen's (1999) framework, for Malaysian educators in tertiary education, who want more flexible options in their classroom teaching methods, and to inculcate their students with better real-world skills. More research can be done, however, in investigating further the role of multimedia in motivating students, and the group dynamics within such a learning environment.

Conclusion

The study was thus successful in providing students with the experience in problem-solving, critical-thinking and creativity skills, communication and reflection, and in improving their overall understanding of the project's objective, as students reported satisfaction with their contributions. They also became active participants in their learning process. The project also allowed students to become more independent in their thinking and as a whole, enabled them to improve their learning process.

Adapting Jonassen's (1999) proposition for building a constructivist learning environment using technology in this classroom environment created a learning environment where students were able to solve a problem, via the interactive multimedia project, that was authentic and relevant to them, and allowed them to collaborate and work together as a team to complete the project, and to claim responsibility and ownership of their development process. This multimedia-mediated learning environment allowed students to experience a constructivist-based approach in their learning process where they became active participants and constructed their own knowledge. Although the students reported that there were some challenges in teamwork and collaboration, it did not deter them from having an overall positive attitude towards the project. Therefore, this research study has shown that incorporating multimedia technology into a constructivist learning environment can lead to innovative teaching and learning methods for the improvement of classroom learning.

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