

Designing a Computer-supported Project-based Learning Environment for High School Students: A Case Study

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Abstract

This study investigated the perceptions and learning experience of 151 high school students in a computer-supported project-based learning environment. The learning environment was evaluated quantitatively using the validated Web-based Learning Environment Instrument (WEBLEI) (Chang & Fisher, 2003). Qualitative data in the form of individual students' written feedback provided triangulation with the quantitative data collected. The findings show that the students experiencing a computer-supported project-based learning environment benefited by being helped to achieve learning outcomes. However, the face-to-face setting of the learning environment was found to have contributed more to their preferred individualized and group learning.

1. Introduction

A learning environment refers to the conditions, circumstances, and influences that affect the learner's development cognitively, socially, and psychologically. This means that every aspect of the milieu is an element in the learning environment, which can catalyze or stifle the individual's activities (Lever-Duffy, McDonald, & Mizell, 2003). Besides the physical learning space that can have an impact on the teaching-learning processes, the non-physical components such as the instructional strategies, student-teacher interactions, and assessment techniques also play equally important roles in the learning environment. Educators need to pay close attention to designing effective learning environments for engaging and managing students in meaningful learning.

2. Literature Review

The incorporation of technology into classrooms has brought about concerns and hopes for educators and researchers in designing appropriate pedagogy to orchestrate the learning environments such as blended learning, Web-based learning, and e-learning, which are available in higher institutions and schools. In the field of Computer Mediated Communication (CMC), the technology exists in either synchronous or asynchronous communication forms to allow for learner-to-learner, learners-facilitator, and learner-resource interactions. In this study, the project-based learning environment incorporated asynchronous online discussions from the Knowledge Community (KC) platform. The emerging practices of incorporating asynchronous discussions (Schallert, Reed, & the D-Team,

2004) into face-to-face classrooms in schools has raised issues pertaining to the affordances of technology, teacher competencies, student learning styles, scalability, and sustainability of technology for existing and future schools (Churchill, in press; Fitch, 2004; Zurita, Nussbaum & Salinas, 2005). Thus far, there are relatively few studies conducted on the Singaporean high schools' computer-supported project-based learning environment (Jamaludin & Quek, 2006a, 2006b; Seet, 2006; Seet & Quek, in press). This study aims to provide an insight into what high school students experienced in a computer-supported project-based learning environment. The study also investigated how their "voices" can be tapped for designing a more effective computer-supported project-based learning environment for use in Singapore schools.

The design of constructivist learning environments embraces aspects of learners' prior experiences, active learning roles, and forming of a learning community with peers. Numerous learning environment studies have been conducted across other cultural context (Burns, 2004; Grant, 2002; Hmelo-Silver, 2003; Mergendoller & Thomas, 2002). Amongst these past studies, Bransford, Brown, and Cocking (2000) highlighted learner-centered, knowledge-centered, assessment-centered, and community-centered perspectives in designing effective learning environments. Other researchers (e.g., Wang, in press) highlighted pedagogy, technology and social aspects to be essential in designing constructivist learning environments. For this study, the proposed computer-supported project-based learning environment (Figure 1) draws on three perspectives: Psycho-socio, pedagogy, and technology. Psycho-socio design of the environment focuses on both the environment (be it face-to-face or Web-based) and its interaction with the personal characteristics of the learners that determine the behavior of individuals. Pedagogical design of the environment allows for active learning and co-construction of knowledge among learners. Technological design allows for learner access anytime and anywhere and the ease of use of technological tools to support learners' learning.

Teacher-facilitators have the potential to influence how learners interact with one another in the computer-supported learning environment (Kim, Anderson, Nguyen-Jahiel, & Archodidou, 2007). For example, the facilitators determine how interaction rules can be continuously reinforced in the computer-supported learning environment. They monitor

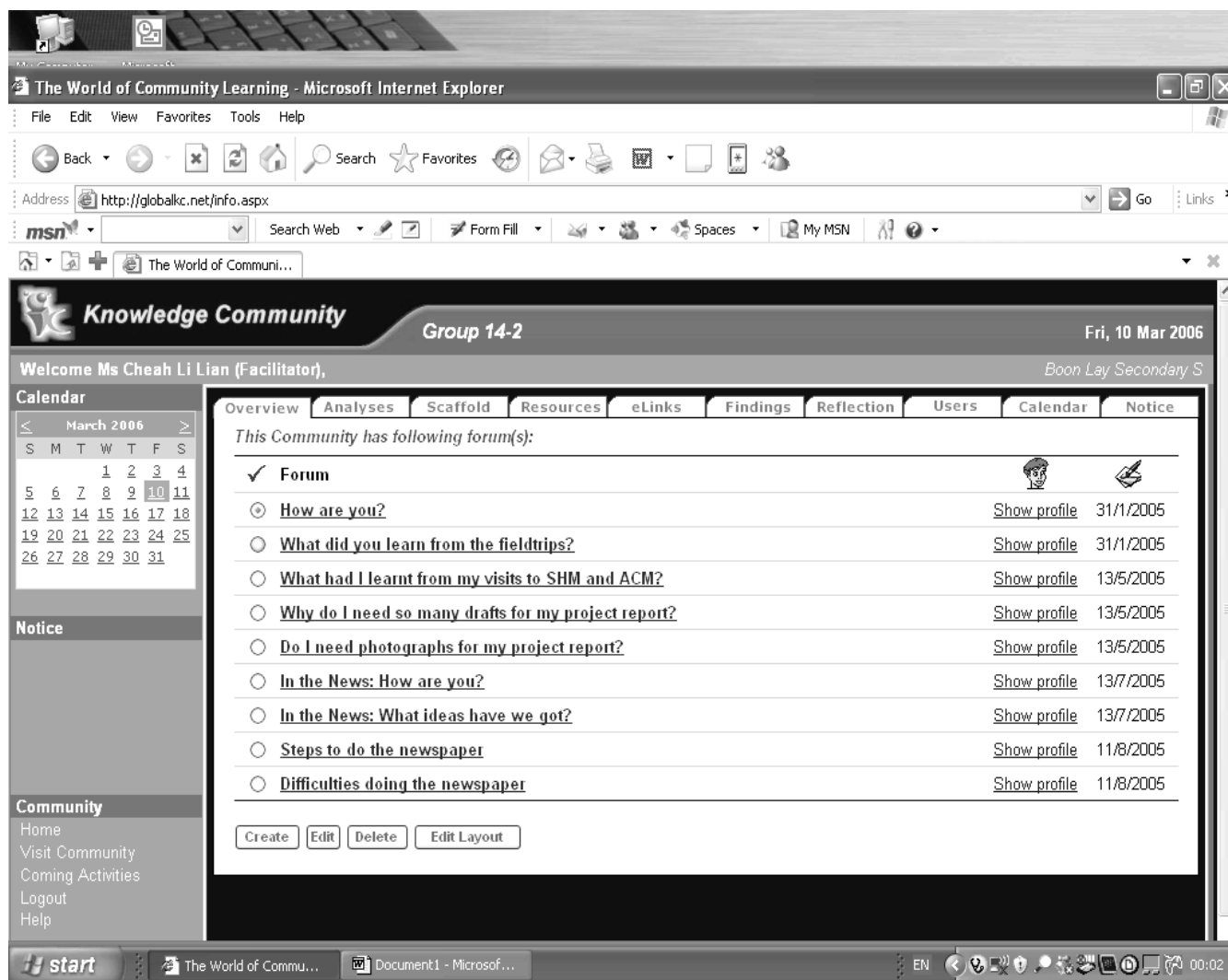


Figure 1: Design of computer-supported project based learning environment

and regulate the interactions and intervene pedagogically to direct the group productively towards successful collaborative learning (Dillenbourg, 1999). Most importantly, facilitators need to know “when” and “how” to create opportunities for students to participate in constructivist and collective discourse within the community (Hmelo-Silver & Barrows, 2008).

Students’ collaborative learning requires their coordinated effort and involvement in articulating shared understanding in project-based learning. Group members may be engaged in learning to share ideas and evaluate information that require critical, creative, and complex thinking (Zurita, Nussbaum & Salinas, 2005). It was reported that students gained new competencies and knowledge in the “discussion-oriented” learning environment as compared to the

traditional and didactic teaching oriented learning environment (Bereiter & Scardamalia, 2003; Hew &

Knapczyk, 2007; Lipponen, Rahikainen, Hakkarainen, & Palonen, 2002). As researchers continue to seek pathways in designing effective learning environments, it is therefore necessary to inquire into students’ experiences and perceptions of their learning environments with the aim of designing improved learning environments for building student capacity such as student learning, performance, confidence and improved attitudes (Chung, Shel, & Kaiser, 2006; Fitch, 2004; Heath, Herman, Lugo, Reeves, Vetter, & Ward, 2005). In this study, the two research questions are:

- a. What are the students’ perceptions of the computer-supported project-based learning environment when evaluated using Web-based Learning Environment Inventory (WEBLEI)?

- b. What happens to students' learning in the Normal and Express streams in computer-supported project-based learning environments?

3. Method

The sample consisted of 151 students (aged 13-14, grade 7) from four classes (two Normal Stream and two Express Stream) who volunteered and participated in this study. Student inclusion was more of a convenience sampling based on the school's choice of classes after the researcher was granted permission to conduct the study. There were 73 students who came from the Normal Academic stream (students who are of below average ability in the school's academic performance) and 78 from Express Streams (students with average and above average ability in academic performance). In each class, there were two project teachers who facilitated students' online and face-to-face learning during the entire project implementation. The students were assigned project groups. Grouping of students was randomly decided by the teacher-facilitators. There were 32 groups formed from the given sample. The technology used in this study was the Knowledge Community (KC), an asynchronous computer mediated communication tool. Teachers were inducted into the asynchronous online discussion. The implementation of project-based learning was 10 weeks (one hour of curriculum time per week) and it was conducted in either the classrooms or the computer laboratories. The students received just-in-time instruction on ground rules of participating in forum discussions in the project-based environment (Figure 1). At the end of the project cycle, students presented their projects and artifacts during the school's Museum Night event.

Procedure: The phases and activities of implementation of project-based learning are shown in Table 1. Teachers led the students in a warm-up discussion forum and then the five structured discussion forums so that students could participate within each project group fortnightly throughout the entire duration of the project cycle. The forum titles were planned similarly across both the Normal and Express streams classes by teachers.

Instrument: Based on the earlier work by Tobin (1998), Chang and Fisher (2003) state the WEBLEI is a reliable (alpha reliability of 0.68 to 0.87 for four scales) and validated instrument used in higher education in the original study by Chang & Fisher (2003). Wong et al. (2006) used the modified version of WEBLEI to conduct a study involving 260 students and 26 teachers across seven secondary schools in technology-supported project-based learning environments. The results showed that each WEBLEI scale displayed satisfactory internal consistency (alpha reliability from 0.78 to 0.91) for all four scales of WEBLEI. In a comparison of perceptions of students' actual (refers to actual situations) and preferred versions (refers to ideal situations) of WEBLEI, it was found that preferred

perceptions were more favorable than actual perceptions for both teachers and students. It was suggested that one of the ways to address the differences in actual and preferred perceptions is by providing better and longer access to physical resources like computer laboratories and more shared materials to enable both teachers and students to effectively use this Web-based technology.

There are four WEBLEI scales that are used to evaluate the computer-supported project-based learning environment (Figure 1). WEBLEI Scale I (Emancipatory activities) describes the usage pattern such as convenience, efficiency, and autonomy. WEBLEI Scale II (Co-participatory activities) refers to the group learning processes such as flexibility, reflection, quality, convenience, efficiency, and autonomy in relation to the students' participation and collaboration in the learning activities to achieve their learning outcomes. WEBLEI Scale III (Qualia) relates to the feelings and learning attitudes in terms of enjoyment, confidence, accomplishments, success, frustration, and tedium. WEBLEI Scale IV (Information structure and design activities) refers to academic factors such as relevance and scope of content, validity of content, accuracy, and balance of content, navigation, aesthetic, and affective aspects. This scale deals with how the Web-based learning materials are structured and organized and whether the materials presented follow accepted instructional design standards, such as stating its purpose, describing its scope, incorporating interactivity, or providing a variety of formats to meet different learning styles of learners. The Results scale assesses whether the students have benefited from the learning environment.

A slight modification was made to the original WEBLEI in terms of rephrasing a few items to suit the Singapore school context. The WEBLEI (five-point Likert responses) was administered to students at the beginning to find out what they would like to experience and then at the three quarter mark of the project implementation to find out what they actually experience. The WEBLEI (Preferred and Actual) would be analyzed and compared. A free-response questionnaire was also administered to gather students' qualitative feedback on their project-based learning at the end of the project cycle. The questions were:

1. What do you enjoy or not enjoy in this project-based learning? Why?
2. What changes would you like to see in this project-based learning? Why?
3. Did you learn anything about project-based learning and the environment? Give examples.

Analysis: Using the individual student as the unit of analysis, the quantitative data was analyzed using SPSS (Version 15) to calculate the means, standard deviation, paired sample t-test, and alpha reliability. Using the

meaning as the unit of analysis, students' comments were coded according to the subcategories within the WEBLEI scales as shown in Table 2.

Frequency and percentages of comments that corresponded to the different sub-categories of each WEBLEI scale as well as the percentage difference between Normal and Express Stream were also calculated. The alpha reliability of WEBLEI ranged from 0.79 to 0.88 for all the four WEBLEI scales indicating strong reliability for the sample used in this study (Table 3).

4. Findings

4.1 Students' Perceptions of Their Learning Using WEBLEI (Research Question 1)

Table 3 shows the scale mean, mean, and standard deviation of WEBLEI. The preferred and actual versions of WEBLEI showed that the item means for the students' preferred perceptual scores ranged from 3.5 (Interaction and Response scales) to 3.8 (Results scale), while the students' actual perceptual scores ranged from 3.5 (Access and Response scales) to 3.9 (Results scale). On the whole, the item means obtained for both actual and preferred versions of WEBLEI were high. There was no significant difference found between the preferred and actual forms of WEBLEI when paired sample t-test was calculated at 95% confidence interval.

4.2 Students' Views on Computer-supported Project-based Learning Environments

Table 4 summarizes the students' coded comments according to the various aspects of WEBLEI scales. However, there were a few comments that could not be coded due to ambiguity and incomplete sentences.

4.2.1 WEBLEI Scale I – Emancipatory Activities

WEBLEI I scale includes aspects such as convenience, efficiency and autonomy. Both Normal (23%) and Express (26%) stream students experienced Efficiency and Convenience in the computer-supported project-based learning environment. It was also found that there was little evidence (3%) of autonomy experienced by students in this computer-supported project-based learning environment.

Efficiency was achieved through having few tests or examinations and therefore allowed for efficient use of time. This perception appeared in the feedback given by students from the Express (9%) and Normal (23%) streams. Most of the students perceived project-based learning to be collaborative and conducted over a period of time resulting in less work overall, thus allowing for more efficient use of time. In comparison, 14% more Normal stream students perceived greater efficiency in the use of time compared to Express stream students.

“I like it because there is only end of the year final examination, there's less work and it is quite easy.”

“I like it because the marks given are according to our daily work and project work that I have done, saving me from the 'fate' of memorizing things.”

“I like this program because it has lightened my workload. It contains less homework, less revision and less work to be done. As it requires only a project to cover five subjects, we can concentrate more on the other important subjects.”

Convenience was achieved when students could access the learning activities at their own convenient times (beyond school curriculum hours). There were 23% more Express stream students who complained of difficulty in accessing the school computers after school hours and lack of access to technology in homes without computers. The inconvenience of access was perceived in the written responses by Express stream students who were concerned with being unable to use the school computers at convenient times after school. The cost of using computers in terms of time and money was also considered an inconvenience. There was a suggestion to extend the opening hours of the school computer lab to provide greater access for students.

“... when preparing the product of our project such as the newspaper, the teachers sometimes want the information typed out and printed, but this is troublesome as the school computer labs are crowded after school and as it closes early we had to do it at home. Some of us do not have a computer or printer or both.”

“The project is more difficult than the exams. We have to use the computer to do our project. This will make me more stressed. There would be computer lessons and we must pay by Edusave (government funding). I think the computer lesson is no use.”

“The computer labs in school should close at 6pm not 5pm. It's far too early and during examination times it will be closed.”

4.2.2 WEBLEI Scale II – Co-participatory activities

WEBLEI scale II includes aspects such as flexibility, reflection, quality, interaction, feedback, and collaboration. Both Normal and Express stream students experienced collaboration (13%-14%). On the other hand, students from Normal (48%) and Express (30%) streams experienced interaction in the computer-supported project-based learning environment. Below 10% of the students reported that they did not experience flexibility, reflection, and quality in learning.

Collaboration was achieved by a variety of student activities. The students perceived the collaboration positively. Many students were pleased with the increased opportunities to make more friends as a result of their collaborative project-based learning. There was preference for group work with good facilitation from teachers who gave clear instructions.

“I like project-based learning as we can work in groups and know our group members well. We also have more idea(s) to consider. The project-based learning is new and it can help us to get close to our friends by doing projects and doing research.”

“It had helped me to make more friends by doing projects in groups.”

Interaction includes enabling students to interact with others asynchronously. There were mixed reactions to the online asynchronous interactions and comments show differences, which appeared to be personal preferences. Whilst the novelty of this mode of interaction appealed to one student, there were others who found it a chore to engage in such an activity.

“I like it because we can go online and type out our opinion. This is very interesting and this is our first time doing an online project.”

“I also don’t like project-based learning because we have a lot of projects to do.”

More students from the Normal (48%) than the Express (30%) streams expressed such responses (18% difference) based on the students’ written comments.

Feedback includes both the teacher and student giving their advice and views to the individuals concerned during the project-based learning. It was found that more Express stream students shared opinions and similar thinking about the lack of mid-year examinations and common tests for the subjects in project-based learning. They perceived this removal of mid-year examination and term tests as being a shortcoming as it did not provide sufficient feedback to them with regards to their standards and performance compared to the commonly adopted pen and paper assessments. Some students commented on the lack of fairness in project-based learning’s mode of feedback or assessments.

“Teachers gave us much help, ideas and information.”

“In the project-based learning, I like the part when we do worksheets and oral presentation and the teacher will allocate marks based on these. This will enable us to put in our effort and do our very best.”

“There is no mid-year exam since we only do one group project. We are not tested on certain subjects but in the end of year exams all subjects have tests. But if we do not have tests for End of Year, then we do not know our standards because we depend on project-based learning for certain subjects.”

In summary, students’ concerns were expressed from their positive and negative views about the feedback through project-based assessments. They wanted more direct feedback from their teachers about their performance.

4.2.3 WEBLEI Scale III - Qualia

WEBLEI III scale was analyzed in terms of enjoyment, confidence, accomplishments, success, frustration, and tedium. Students from both the Normal (33%) and Express (21%) streams reported that they enjoyed the computer-supported project-based learning environment. The Normal stream students (34%) found more accomplishments than the Express stream students (6%). On the other hand, Express stream students (24%) found more frustration than the Normal stream students (6%). There was little evidence found from the student responses (below 10%) showing confidence, success, and tedium in the computer-supported project-based learning environment.

Enjoyment was associated with academic success and ease of using technology. Generally, both Normal (33%) and Express (21%) students found project-based learning fun and interesting because of the activities, which involved them and their peers. Examples of association between enjoyment and academic success can be seen in the following student comments:

“I love project-based learning as it helps to reduce stress that comes from doing written exams and it is also fun to do projects, using computers, having meetings – it’s like (having) a social life.”

“It is fun and exciting as I got to learn many things in different ways.”

“I like project-based learning because teachers teach in a fun way. This helps us to be motivated and to study more.”

In the feedback given by students from both streams, there was no mention of enjoyment from the mastery of technology. Nevertheless, the students enjoyed their project-based learning activities, although they did not consider the mastery of technology as a contributing factor to their enjoyment.

Accomplishments were associated with allowing student to display their course accomplishments regularly and

publicly. A difference of 28% was found between the Normal and Express stream students' perceived performance and social skills to public speaking and presentation skills.

"I really learned to be a good presenter because now when doing presentation I can speak well and confidently."

"I had to learn about how to pronounce words clearly and to spell correctly."

"I have learned a lot of things in project-based learning like being able to speak and to present our project work very fluently and I had to become cooperative with my group members. I also become more responsible as I did the work on time."

Most of the comments in this category were from the Normal Stream students (34%) who articulated their specific accomplishments through project-based learning. A much smaller percentage of Express stream students (6%) described their accomplishments. Generally, the academically weaker students wrote more about their accomplishments through project-based learning.

Frustration was at first examined in terms of technology and the conceptual aspects of the program. It was found that the Express stream students (24%) indicated their frustration more than the Normal stream students (6%). On the whole, the frustration expressed by students did not single out any problems with technology but described difficulties in understanding the processes in project-based learning and group work. There was also some unhappiness over the assessments and grading in project-based learning. Frustration was perceived mostly by the Express stream students. Some of them expressed that:

"Personally, I do not like the project-based learning held this year. For me, it demands too much work from my group and I. The newspaper takes a lot of time to get it done. I cannot really focus with my other subjects like science, literature and mother tongue."

"I think that project-based learning is unfair to those who put in a lot of effort. Those who did not do work in the group get the same grade as those who put in a lot of effort."

4.2.4 WEBLEI Scale IV – Information Structure and Design Activities

WEBLEI scale IV was examined in terms of relevance and scope of content, validity, accuracy, and balance of content, navigation, aesthetic, and affective aspects. Both Normal (25%) and Express (18%) stream students found relevance of content and scope of content. There was hardly any

accomplishments. Students expressed their accomplishments that ranged from better examination evidence found in validity, accuracy, and balance of content, navigation, aesthetic, and affective aspects (about 10% and below).

Relevance and Scope of Content refers to how relevant the content appeared to students and how extensively it covered their syllabus and beyond the syllabus. Comments show an appreciation of the scope of the project-based learning, which goes beyond the normal textbook information and allows students to experience and explore topics in more depth than usual. One student described the relevance of the program in relation to their learned life skills such as the problem-solving.

"It has taught me many things that I have not experienced before."

"We learned many things that are not in textbook."

"I like project-based learning because after we do the project, we can learn a lot of things. It also lets us know about Geography, History, Music and so on. In the future, we can use all these knowledge to solve lots of problems, so that we can become more clever, and it increases our knowledge."

Normal (25%) and Express (18%) stream students appreciated the scope of the project-based learning that allowed them to have more depth and future relevance. Students also appreciated the result-oriented and beneficial learning environments, which was relevant in scope and content.

5. Discussion

Students' perceptions of the computer-supported project-based learning environment provided two levels of insight towards designing an effective learning environment. The first level information speaks to student perceptions of the environment and the second level information reveals how different groups of students react towards a project-based learning environment.

The highest item mean obtained for Results scale could be due to the teachers' instructional strategies used in computer-supported project-based learning. Specifically, field trips, forums, and just-in-time skills were found by students to be relevant and meaningful to their learning. Students expressed that their learning gains include opportunities to play active roles and ownership of their own and group learning, as well as integrated learning in computer-supported project-based learning. However, most of them had found that their out-of-classroom activities such as field trips and the culminating exhibition event (Museum Night) had a motivating impact on them. These learning

experiences contributed to their positive perceptions. However, there was no evidence showing how their out-of-class experiences were supported by technology in this study. This was an area of concern and more could be further discussed and with suggestions made.

Access - The students' problem of physical barriers to the use of technology in schools should be identified early and solved quickly by the project teachers. This change is to materialize the potential benefits of computer-supported project-based learning environments.

Interaction Students wanted more immediate feedback from teachers and peers. At the teachers' level, this could be related to the technological affordance and the teachers' ease of using the technology to facilitate project-based learning. Teachers could use the "Analysis" function to share feedback with students more frequently at the individual and classroom levels. It is also necessary for teacher-facilitators to equip themselves with skills on successful management of student interactions in Web-based learning environments (Glenn, Jones & Hoyt, 2003). A suggestion would be to set up a teacher's forum to discuss issues of facilitation in Web-based discussions as part of professional development. Another suggestion would be to improve teacher efficacy through collaboration with colleagues in developing content materials and strategies for project-based learning.

Response - Students unanimously expressed their enjoyment of computer-supported project-based learning such as the field trips and excursions. However, their enjoyment was rarely attributed to the use of forum discussions. A suggestion would be for teachers to integrate forum discussions into student learning in both the online and face-to-face classroom settings. Students indicated that they gained confidence in social, public speaking, and presentation skills. These are important life skills that teachers could reinforce in a project-based learning environment. The Express stream students' frustrations ought to be treated seriously by the teachers. Their frustrations did not single out problems with technology but mainly on the difficulties in understanding the processes related to project-based learning, group work, and dissatisfaction in the assessments and grading. These are curriculum and assessment matters that teacher-facilitators should explore; namely, the pedagogy and the affordance of the technology to better engage and manage students' individual and group contributions in the light of assessment for learning and assessment of learning.

Result - Students found the scope of project-based learning to go beyond the normal textbook information. They experienced and explored topics in greater depth than usual. This conclusion is also because findings point to the fact that students had a strong preference for learning

environments that helped them achieve good results via projects that replaced the formal examinations. The curriculum for project-based learning should continue to provide rigor for students' learning by allowing for self-directed and collaborative learning in the computer-supported project-based learning environment.

6. Conclusion

This study has shown that students' perceptions provides an insight into the design of the computer-supported project-based learning environment and how it could be further improved and addressed by research. In terms of the psycho-socio aspect of the learning environment, the students had indicated the aspects that they perceived to have benefited their learning. Effective use of asynchronous discussions to engage learners in a collaborative manner for project-based learning needs to be addressed seriously. Successful implementation of computer-supported learning environment is often the result of the teachers' pedagogy, understanding of technology affordance, and facilitation processes that help to map out the entire learning space for students.

This study focused on evaluating the computer-supported project-based learning environment for students of the Y and Z generations. Further investigations should pay attention to how student learn and the extent of taking student voices into account when designing for learning and instruction in computer-supported learning environments. However, such research efforts may become futile if teachers and educational practitioners continue to hold the belief that students are not the best judge of what is appropriate for their own learning in today's education arena.

Insights provided by students about the computer-supported project-based learning environment should continue to serve its purpose to help the schools gain better understanding of various issues pertaining to the learners, pedagogy, and the technology deployed. These insights provide the necessary background knowledge and information for timely interventions before future or further implementation of similar program. School-based research should focus on students' critical voices and continued conversations with students in order to innovate and design effective learning environments for the students.

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Choon Lang enjoys teaching, learning and developing curriculum for schools. She supervises and has graduated postgraduate students. She teaches pre-service, in-service, and post-graduate courses.

Table 1

Roadmap on the Planning and Implementation of Project-Based Learning

Researcher's Activity	Project-Teachers and Student Activities in a School
1 - Wrote in to the school for permission to conduct the research - Conducted briefing followed by training to participants	<ul style="list-style-type: none"> • Briefing for teachers on project-based learning • Teacher training session on the use of technology, Knowledge Community (Known as KC, a commercially available asynchronous tool for forum discussion)
2 - Discussed with school coordinator and supervisor on processes of data collection	<ul style="list-style-type: none"> • Assign accounts for students on the Web portal by coordinator and forming discussion groups. • Warm-up stimulus activity and practice online discussions
3 - Observed project-based lessons in the classroom and online classes	<ul style="list-style-type: none"> • Field trips followed by online activities with peers • Discussion of project through Face-to-face & online group discussions
4 - Administered research instruments - Administer free response questionnaire	<ul style="list-style-type: none"> • Oral presentation, exhibition of group projects and submission of group report. • Pupil reflection and free response questionnaire

Table 2
Category and Indicators Used for the Data Analysis

WEBLEI Scale	Category	Indicator
I Emancipatory activities (Access)	Convenience	<ul style="list-style-type: none"> • access to learning activities at convenient times • efficient use of time through fewer tests and exams • being able to decide when and how to access the curriculum
	Efficiency	
	Autonomy	
II Co-participatory activities (Interaction)	Flexibility	<ul style="list-style-type: none"> • they are allowed to meet their goals • reflective interactions through asynchronous discussions • learning in the level of activity they undertake • Web-based asynchronous interaction with others • availability of feedback from students and the teacher • opportunities to collaborate in a variety of activities
	Reflection	
	Quality	
	Interaction	
	Feedback	
	Collaboration	
III Qualia (Response)	Enjoyment	<ul style="list-style-type: none"> • academic success and mastery of technology • success and support for their learning • opportunities to display their course accomplishments regularly and publicly • effective use of technology and learning of concepts • ineffective teaching of concepts and use of technology • enforced regular posting and responding to reviews
	Confidence	
	Accomplishments	
	Success	
	Frustration	
	Tedium	
IV Information structure and design activities (Results)	Relevance and scope of content	<ul style="list-style-type: none"> • relevance of the content and how extensively it covered their syllabus and beyond the syllabus • how closely the content relates to the subjects learned to make it useful for them in their academic studies • whether there is a good combination of subject matter and the correctness of the content • how to move from one part of the Web-based environment to another for discussions and other Internet activities • creation of products and processes, which appeal to their senses • products and processes, which promote positive feelings and character development
	Validity of content	
	Accuracy and balance of content	
	Navigation	
	Aesthetic	
	Affective	

Table 3

Internal Consistency Reliability, Scale Means and Standard Deviations for Actual and Preferred Versions of the Modified WEBLEI for Students

Scale	No. of Items	Form	Alpha reliability	Scale Mean	Scale Standard Deviation	Item Mean
Access	7	Actual	0.80	24.9	0.7	3.6
		Preferred	0.70	24.5	0.6	3.5
Interaction	8	Actual	0.79	28.1	0.7	3.5
		Preferred	0.71	28.5	0.6	3.6
Response	8	Actual	0.83	27.7	0.7	3.5
		Preferred	0.77	27.9	0.6	3.5
Results	8	Actual	0.88	30.6	0.7	3.8
		Preferred	0.82	31.3	0.6	3.9

N=151

Table 4
Number and Percentage of Students' Comments on Categories of WEBLEI Scales

WEBLEI Scales	Normal Stream (N=73)	Express Stream (N=78)	Percentage difference (%)
	Number (%)	Number (%)	
<u>Scale I (Access)</u>			
Convenience	2 (3)	20 (26)	23
Efficiency	17 (23)	7 (9)	14
Autonomy	0 (0)	2 (3)	3
<u>Scale II (Interaction)</u>			
Flexibility	0 (0)	1 (1)	1
Reflection	0 (0)	6 (8)	8
Quality	2 (3)	2 (3)	0
Interaction	35 (48)	23 (30)	18
Feedback	6 (8)	12 (15)	7
Collaboration	10 (14)	10 (13)	1
<u>Scale III (Response)</u>			
Enjoyment	24 (33)	16 (21)	12
Confidence	5 (7)	7 (9)	2
Accomplishments	25 (34)	5 (6)	28
Success	3 (4)	4 (5)	1
Frustration	4 (6)	19 (24)	18
Tedium	3 (4)	0 (0)	4
<u>Scale IV (Results)</u>			
Relevance and Scope of Content	18 (25)	14 (18)	7
Validity of Content	5 (7)	8 (10)	3
Accuracy and Balance of content	1 (1)	3 (4)	3
Navigation	1 (1)	6 (8)	7
Aesthetic	6 (8)	3 (4)	4
Affective	1 (1)	2 (3)	2

N=151, Percentage do not add up to 100% due to a small percentage of uncoded comments found in the sample.

Appendix A: Web-Based Learning Environment Instrument

Access

- 1 I can access Web-based learning environment at times convenient to me.
- 2 The Web-based learning environment resource is available at locations suitable for me.
- 3 I am allowed to work at my own pace to achieve learning objectives of the project based lesson.
- 4 I decide how much I want to discuss in a given period.
- 5 I decide when I want to initiate discussions.
- 6 I am allowed flexibility to meet my learning goals.
- 7 I am allowed flexibility to explore online resources, which I am interested in.

Interaction

- 8 I communicate with other students in this subject electronically (Web-based discussions).
- 9 In this learning environment, I have to be self-disciplined.
- 10 I have the autonomy to ask the teachers what I do not understand.
- 11 I have the autonomy to ask other students what I do not understand.
- 12 Other students respond promptly to my queries
- 13 I regularly reflect on what I have said in the online discussions.
- 14 I regularly reflect on what my group members have said in the online discussions.
- 15 I was supported by positive attitude from my group members.

Response

- 16 This mode of learning enables me to interact with other students and teachers asynchronously (in a Web-based environment but not at the same time).
- 17 I felt a sense of satisfaction and achievement about this learning environment.
- 18 I enjoy discussing in this Web-based environment.
- 19 I could discuss more in this Web-based environment.
- 20 It is easy to organize a group for an online discussion.
- 21 It is easy to work collaboratively with other students involved in a group discussion.
- 22 The Web-based learning environment held my interest throughout PW lessons.
- 23 I felt a sense of boredom towards the end of PW lessons.

Results

- 24 The scope or learning objectives are clearly stated.
- 25 The organization of each online discussion forum is easy to follow.
- 26 The structure keeps me focused on what is to be discussed.
- 27 Expectations of tasks and roles are clearly stated in the Web-based environment.
- 28 Activities are planned carefully
- 29 The project based learning resources and Just-in-Time lessons are appropriate for delivery on the Web.
- 30 The presentation of the forum topic is clear.
- 31 The discussions and reflection log enhanced my learning process.