EXAMINING THE EFFICACY OF PROJECT-BASED LEARNING ON CULTIVATING THE 21ST CENTURY SKILLS AMONG HIGH SCHOOL STUDENTS IN A GLOBAL CONTEXT

By

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ABSTRACT

The goal of the study is to explore the opportunities and challenges associated with Project Based Learning strategy in a global context on the aspects of both fostering learning community of practices and nurturing the 21st century skills. For collecting empirical data, the study implements and administers an online international project-based learning program for high school students. Since it is claimed that interpersonal interaction is key to the success of online project-based learning programs, the study first focuses on investigating patterns of community of practice, which is a combination of online learning behaviors and interpersonal interaction, among students against a claimed theoretical framework. For unveiling the impacts on fertilizing the 21st century skills, the study examines the perceptions of students and teachers participating in the online international project-based learning program. Results of the study confirm the asserted theoretical framework regarding the community of practices and reveal that students of various countries perform differently in terms of community of practices in virtual learning space. As to building the 21st century skills on students, the study credits the project-based learning strategy deploying in a global context for providing intuitive and essential aspects of learning ingredients to students for pursuing skills related to Communication, Collaboration, Complex Problem-solving, Critical Thinking, and Creativity.

Keywords: Community of Practice, Virtual Learning Environments, Project Based Learning, International Collaborative Learning, Online Learning Behaviors.

INTRODUCTION

There is a widespread belief that Information and Communication Technology (ICT) can and will empower teachers and learners, transforming teaching and learning paradigms from being highly teacher-dominated to student-centered, and that this transformation will result in increased learning gains for students, creating and allowing opportunities for learners to develop their creativity, problem-solving abilities, collaboration skills, communication skills, and critical thinking skills. However, there are currently very limited data to support this belief.

Furthermore, a study conducted by Organization for Economic Co-operation and Development (OECD, 2011), examines how students' access to and use ICT over the years and explores how different National Education systems are integrating ICT into students' learning experiences and claims that educators have not yet become good enough at the kind of pedagogies that make the most of technology even in advanced countries. With the full adoption of ICT in sight in schools, educators are therefore under pressure to implement and demonstrate effective pedagogical practices.

1. Literature Review

Project Based Learning (PBL) is a premium pedagogy that has four main components: (1) a realistic problem, (2) structured group work, (3) multi-faceted assessment, and (4) participation in a professional learning network (Buck Institute for Education, 2009; Moursund, 2003). On the other

hand, it has been claimed that the 21st century skills such as critical thinking, problem-solving skills, communication skills, collaboration skills, and creativity are essential for the modern citizenship (Reigeluth & Karnopp, 2013). PBL, in the mean times, has been considered long as a significant student-centered approach to engage students and cultivate the 21st century skills on them (OECD, 2011; Reigeluth & Karnopp, 2013). Whereas, it has been proposed that the best practice of PBL is in networked learning environments energized with learning community (Lin & Ma, 2011).

Indeed, more and more results of research reveal that interpersonal communication among learners can lead to an enhanced performance for all in the scenario of networked learning (McFarlane, 2006; Di Blas & Poggi, 2008). By fostering interaction among people who use them, networked learning environments indeed support deep learning and high level of engagement in practice. Bronack et al. (2006) asserted that networked learning must account for the social nature of learning. They claim that learners are compelled through actions as members of a community in networked learning environments. The growth and development of learners lie at the confluence of effort and reflection, within the context of meaningful scenario and activity, as individual learners become increasingly central participants within the community. It implies that participation within a community of practice prompts both more- and less-experienced members to engage in reflective thinking and complex problem-solving. It is a widely accepted claim that by fostering interaction among experts, peers, learning objects, and activities in formal, informal, and serendipitous ways, a networked learning environment embedded with community of practice can help learners attain their constructive knowledge (meta knowledge), instead of cognitive knowledge alone. Of the many tools that can be used to facilitate collaborative learning, Tarsiero (2007) asserted that community of practice is promising, especially in addressing unstructured learning tasks that are impossible to foresee and too complex to formalize such as the PBL. Nevertheless, the fostering of learning community and meaningful communication taking place in it cannot be taken for granted; examples of unsuccessful attempts to encourage learners to incorporate online communication to support their learning are common even where the online discussion among learners is a compulsory element of a credit bearing online course (McFarlane, 2006).

Ultimately, building up and sustaining vibrant online learning communities in a networked learning environment is imperative to engage learners in learning process in that it can provide an unbounded social as well as fantastic space for learners, which is essential to the claims of constructive learning theory (Lin & Kuo, 2006). As a matter of facts, online learning communities serve as virtual atmospheres or ambiances that are unparalleled to any existing motivator for engaging interpersonal interactions and are the cores of networked learning environments. The interpersonal interactions such as negotiation, communication, and collaboration that happen inside online learning community could ignite a learner to exchange or reflect his or her newly acquired knowledge with members of the communities, and contribute it into a shared knowledge pool. Tarsiero (2007) also pointed out that online learning Communities Of Practice (COP) tends to involve a higher number of diverse individuals from many regions and countries allowing access to a broader expertise with far lower costs. The facts above imply that the nature of fantasy and versatility in online learning communities might inject the profound human content into and enrich networked learning environments (Friedl, 2003). However, there are few evidences or knowledge so far about how school students behave in the virtual learning environment in terms of learning behaviors and interpersonal interaction.

As to the relationship between PBL and cultivating the 21st century skills, a recent study reveals that teachers who use PBL report more gains of 21st century skills, compared with a closely matched comparison group (Boss, et al., 2011). That means students in PBL classrooms are spending more time learning about important content through experiences that emphasize critical thinking, collaboration, creativity, and communication (Ravitz, et al., 2012). However, it is still waiting for answers about whether the combination of PBL and learning community of practice in a global context might better fostering the 21st century skills

or not.

2. Methodology and Procedure of the Study

2.1 Theoretical Framework

It is asserted that there are five hierarchical levels, which are Observing, Participatory, Contributory, Collective, and Pervasive, in terms of aspects of interactivity and engagement of online users in a virtual space (Operand, 2009). In the beginning of showing up in a virtual space, first and foremost, people usually are simply browsing around and have no control over the selection of content or the pacing of exploration. After a while, people will start to join the online activity and manipulate elements within the activity. When users are getting familiar with the setting, they are enlisted to contribute original content and information. This is just what the Web 2.0 is about. But up to this point, people only pursue interaction with platform or digital content. The next level of interactivity or engagement, which is collective level, starts to involve with the aspect of human interaction. In this level, the diversity of knowledge and viewpoints from a large community can be distilled into a collective wisdom. At the highest level of interactivity and engagement, the interactive experience will become pervasive, which means that online human interaction may seamlessly be embedded into the daily lives of its members of the community. The aforementioned five hierarchical levels of interactivity and engagement are aligned with what Ito (2009) claimed that people would advance from "hanging out" to "messing around", and then to reach the phase of "geeking out" in terms of social networking with Information Technology. The study will explore patterns of learners' online behaviors and engagement following these categories of immersion in a virtual space. Figure 1 depicts the theoretical framework of the online behaviors adopted by the study.

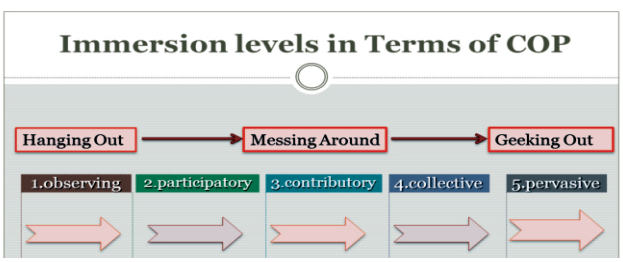

Figure 1. The Theoretical Framework of the Online Behaviors

In 2011, OECD announced the result of the first PISA (Programme for International Student Assessment) survey of digital literacy (OECD, 2011). The result indicates that performance of the kids around the globe over the use of computer and the Internet to learn are different across countries. In the list of the result, Korea, New Zealand, and Australia are on the top. Meanwhile, the result of the OECD survey prompts a further question: Do the kids around the globe also behave differently in the virtual space in terms of their interpersonal interaction?

The comparative studies of global PISA conducted by OECD are receiving attention increasingly across countries and among professionals. The results of the study might verify the results of the PISA and provide better insights about the difference on the performance among involved countries in terms of networked learning behaviors. Furthermore, the special feature with its global context of the study could deliberately provide multiple aspects of perception pertaining to the practices of online learning internationally.

2.2 Instrument and Samples

In order to collect required empirical data and answer above said questions, the study designs and conducts an international online PBL program for K-12 schools hosted on a dedicated international online collaborative learning web site, APEC Cyber Academy (ACA, http://linc.hinet.net/apec/). The APEC Cyber Academy is an International Virtual Learning Environment for K-12 students to interact and collaborate on projects following the principles of social constructivism and self-regulated learning. The main objectives of ACA are:

- Providing a networked learning environment that follows the design principles of HCI to facilitate interaction for learning;
- Utilizing state-of-the-art technology to assist learning and assessment;
- Applying the pedagogical principles of collaborative learning into the design of online activities;
- Fostering international friendship among K-12 learners through online collaboration and computer-mediated communication; and

- Acquiring ICT (information and communication technology) skills through project-based learning.

The ACA is founded on constructivist and self-regulated learning theories. The two theories complement each other well in fostering learner-centered learning strategy. While constructivism emphasizes that knowledge is co-constructed with peers or experts and through immersion in a social context, self-regulated learning places a strong emphasis on cultivating an individual learner's ability to be an autonomous learner. As such, ACA serves as a venue for implementing innovative pedagogy that nurture problem-solving, creativity, critical thinking, and collaborative learning skills (Lin, Chou, & Bagley, 2007).

The international online PBL program of the study allows students and teachers to form teams online and conduct their own PBL projects in global context. The program was publicized through social networks and it attracted a total of 29 teams with 163 high school students from Philippines, Romania, South Korea, and Taiwan. During the five-month duration of the program in 2014, students formed small teams under the supervision of their teachers to participate in the program. The PBL program asks participants to design and carry out their own projects respectively in a team-based fashion. Participants are free to incorporate any media to create digital artifacts about their projects following the project-based learning guidelines set up by the program. The final artifacts of projects, in the form of either videos or web pages, were uploaded to ACA to allow participants to conduct peer evaluation and provide feedback to each other. Figure 2 depicts a showcase of artifact from participants of the program.

In addition to investigating the patterns over community of practice with quantitative data recorded in system log file, ultimately the study also explores students and teachers perceptions of PBL regarding the fertilization of the 21st century skills with surveys and observations. The study attempts to find out whether PBL could boost the 21st century skills on high school students or not.

Figure 2. A Showcase of Students Artifact

2.3 Objectives and Questions

The study is aiming to explore new frontiers in the field of innovative learning practices. There are three unequivocal phases regarding the objectives and questions of the study. (1) Is there a pattern over online learning behaviors among high school students? Does the pattern align with the proposed theoretical framework? (2) Do students behave differently across countries online? (3) Could international online PBL program promote the 21st century skills among high school students? Lin and Ma (2011) once claimed that the best practice of PBL is in networked learning environments with supports of learning community. The answers of three questions of the study might further verify the claim.

3. Results Pertaining to Community of Practice

ACA system log file provides six variables pertaining to the study goals on learning community of practice. The six variables are Frequency of Login (FL), Time Online (TO) in Minutes, Frequency of Rating on Artifacts Committed (FORC), Frequency of Commentary on Artifacts Committed (FOCC), Frequency of Rating on Artifacts Received (FORR), and Frequency of Commentary on Artifacts Received (FOCR). Table 1 presents a glance at these six variables and their values in descriptive statistic measures in team basis.

In the program, each participant is only allowed to provide rating once for each artifact. Hence the total values of FORC and FORR are identical. As to the total values of ıentary variables, which are FOCC and FOCR, they

Variables	Total	N	Mean	SD
FL	2071	29	71.4	45.7
TO	6849	29	236.2	183.1
FORC	399	29	13.8	24.4
FOCC	207	29	7.1	11.3
FORR	399	29	13.8	8.0
FOCR	95	29	3.3	4.0

Table 1. Six Variables in the Study

are not identical due to the fact that the frequencies of expository replying committed by the owners of artifacts are excluded from the FOCR. Although ACA system does not confine the frequency of making comments on every artifact to each participant, both the values of FOCC and FOCR are smaller than their counter parts in rating artifacts. Meanwhile, the participation or engagement of participants in the program is quite high based on both the values of FL and TO variables.

These six variables could be further categorized and corresponded to different levels of immersion in the aspects of learning community of practice based on the theoretical framework of the study. Both FL and TO variables together correspond to the observing level in the immersion hierarchy. The variable regarding with providing rating scores to artifacts, which is FORC, represents the participatory level. The FOCC variable, which is defined as contributing expository comments to artifacts, definitely could represent the contributory level. As to the next level, which is the collective level, it might associate with both FORR and FOCR in that these variables contains the nature of group discussion and exchange of the opinions regarding a specific artifact. Since the variable FORR is only a mirror or reflection of variable FORC in the sense of group performance, however, it will not involve in the discussion about the group immersion levels of community of practice. The upmost level of the immersion hierarchy, which is the pervasive level, could be presented by both the ratio of values between contributory level and participatory level and the ratio of values between collective level and participatory level.

Based on the above definition of the five immersion levels and the data in Table 1, most of the students in the study reach only the contributory level. With ratios of 0.52 and 0.24 respectively in pervasive level, it is quite obvious that only few students reach the pervasive level in the immersion hierarchy of community of practice.

There are several more questions that are prominent to search for answers in terms of variation among countries pertaining to community of practice. Some of the questions are given by,

(1) Is there a difference of performance on the level of observing between students of the four countries?

(2) Is there a difference of performance on the level of participatory between students of the four countries?

(3) Is there a difference of performance on the level of contributory between students of the four countries?

(4) Is there a difference of performance on the level of collective between students of the four countries?

As to the comparison over the performance on pervasive level between students of the four countries, it is omitted here due to the fact that few of the participants reach the upmost level of immersion hierarchy. Tables 2 – 5 are data related to these four questions in descriptive statistics fashion respectively.

Due to the limited number of teams participated in the study, the Kruskal-Wallis analysis, instead of ANOVA, is utilized to compare the differences among four countries on the six variables. Table 6 summarizes the results of the data analysis.

3.1 Is there a difference of performance on the observing level between students of the four countries?

When using data in Table 2 to compare means of FL and TO variables between the four countries with Kruskal-Wallis analysis, it turns out that students from both Taiwan and Philippines have higher frequency of visiting ACA significantly ($p<0.01$) than the students from both Korea and Romania. However, there are no significant differences on time staying on ACA among students of four countries ($p>0.1$), although both Taiwan and Philippines also have longer duration of time online than the other two countries.

Hung et al. (2012) argued that FL is a better indicator of students' engagement and performance online than is the TO. In this regard, students from both Philippines and Taiwan in the study are better than students from Romania and Korea significantly in terms of community of practice in the

	FL				TO			
Country	Total	N	Mean	SD	Total	N	Mean	SD
South Korea	106	3	35.3	7.8	443	3	147.7	110.8
Philippines	940	8	117.5	40.7	1991	8	248.9	80.6
Romania	248	7	35.4	23.7	1469	7	209.9	23.7
Taiwan	777	11	70.6	36.8	2946	11	267.8	286.4

Table 2. Performance on Observing Level between the Four Countries

observing level.

3.2 Is there a difference of performance on participatory level between students of the four countries?

The study defines participation in the community as frequencies that participants of the program are providing rating score to the artifacts. When using data in Table 3 to compare the mean of FORC variable between the four countries with Kruskal-Wallis analysis, results in Table 5 reveal again that students from Philippines and Taiwan perform better in the participatory level significantly ($p<0.01$) than the other two countries.

3.3 Is there a difference of performance on contributory level between students of the four countries?

Writing or providing expository comments on artifacts submitted by peers in the community definitely is a contribution to the knowledge pool. The study compares the mean of FOCC variable in Table 4 between the four countries. The results in Table 6 indicate that performance of students from Korea and Romania are in the bottom and students of Philippines and Taiwan are on the top significantly ($p<0.05$).

It is assumed that providing feedbacks with score is easier than with making comments in peer evaluation. After comparing means of FORC and FOCC variables with t-test for paired samples, it turns out that there is no significant difference here ($t = -1.49$, $df = 28$, $p>0.1$). The result implies not only that the common assumption about the feedbacks with score or comment is not correct, but also that students in the program reach contributory level of the immersion hierarchy.

Country	FORC			
	Total	N	Mean	SD
South Korea	0	3	0	0
Philippines	81	8	10.1	11.4
Romania	0	7	0	0
Taiwan	318	11	28.9	33.5

Table 3. Performance on Participatory Level between the Four Countries

Country	FOCC			
	Total	N	Mean	SD
South Korea	0	3	0	0
Philippines	121	8	15.1	17.5
Romania	1	7	0.1	0.4
Taiwan	85	11	7.7	6.3

Table 4. Performance on Contributory Level between the Four Countries

Country	FORR				FOCR			
	Total	N	Mean	SD	Total	N	Mean	SD
South Korea	3	3	1.0	1.0	9	3	3.0	2.7
Philippines	124	8	15.5	10.3	16	8	2.0	2.8
Romania	139	7	19.9	3.1	5	7	0.0	0.5
Taiwan	133	11	12.1	4.3	62	11	5.9	4.9

Table 5. Performance on Collective Level between the Four Countries

3.4 Is there a difference of performance on collective level between students of the four countries?

When a subject or object in networked learning environments could ignite members of the community to input and share their opinions about it together, which signifies a sign of its strength or quality on pouring in the collective wisdom. In this regard, both FORR and FOCR variables together could represent the performance on the collective level in the immersion hierarchy of the study.

After analyzing FORR and FOCR variables presented in Table 5 with Kruskal-Wallis analysis respectively, results in Table 6 indicate that there is a difference between the four countries in FORR. As to the FOCR variable, the difference of performance between the four countries is not significant. When reviewing the data presented in Table 5 deliberately with the results of the statistical analysis in mind, although the performance of students from Philippines and Taiwan are as steady as in the previous levels, students from Romania is a little bit better off on the level of collective. All of these confounding results is an evidence that students in the program do not reach the collective level of the immersion hierarchy.

4. Results of Survey Pertaining to Building of 21st Century Skills

With regard to the building of the 21st century skills, the study employs a mixed method research that utilized data from surveys, focus groups, and observations. The surveys that

Variables	χ^2	df	p
FL	15.3	3	0.002
TO	2.7	3	0.436
FORC	13.5	3	0.004
FOCC	10.6	3	0.014
FORR	13.3	3	0.004
FOCR	3.9	3	0.268

Table 6. Results of Kruskal-Wallis Analysis

address the research goals were posted online at the end of the international PBL program for teams over all four countries. Three focus groups and observations were conducted with teams at the classroom sites toward the end of the program. A total of 117 student participants (response rate: 72%) and 10 teachers (respond rate: 35%) completed the online survey.

The data from open-ended parts of the surveys, classroom observation notes, and focus group transcripts were collected and analyzed using Nvivo, a qualitative analysis software program. The results can be summarized as followings:

4.1 Communication & Collaboration

Students found that the processes of working with group members and engaging in online peer reviews have helped them to communicate and work better with each other.

4.2 Creativity

The multimedia production process has brought forth many creative project ideas that were not possible in regular class activities.

4.3 Critical Thinking

The creation of the projects has helped the students to expand views about the themes of the projects. The process has also enhanced their critical thinking skills while researching and analyzing data towards drawing the conclusions of the projects.

4.4 Engagement

Students found creating digital projects for international partners a fun activity to engage in.

4.5 Improved Technological Skills

Teachers found that students did demonstrate improvements in utilizing digital media through the projects. The digital literacy and media skills can also aid learning in other courses. For example, students learned how to create digital artifacts and they can also transfer the skills to other courses.

4.6 Increased Sense of Responsibility

Students became more responsible in completing their own projects and working with others.

4.7 Better Time Management

Students were able to deal with deadline better because if they do not get their projects done, the international partners would not have any artifacts to comment on.

The findings from the study have shown many benefits of PBL, especially in an international context. In summary, student and teacher perceptions of international PBL have shown increased communication, collaboration, creativity, and critical thinking skills throughout the process.

Conclusion and Recommendations

Results of the study both confirm the sequential and hierarchical nature of the asserted theoretical framework pertaining to community of practice and reveal that students perform differently among countries in virtual learning space. Based on the consolidate statistic data, the study also realizes that community of practice in the online PBL program has reached the contributory level. The confounding results when comparing the difference of performance between the four countries on the collective level also imply that the community of practice in the program did not reach this level. Under the circumstances of the current schooling environments around the globe, especially in Asian countries which are notorious with college entrance exams combing, performance of the community of practice in the online PBL program implemented by the study is above expectation and far more than admirable. Meanwhile, the study also proves that PBL is beneficial to fostering the 21st century skills on high school students in a global context.

Overall, due to the limitation of the amount of participants across countries results of the study are likely less conceivable, especially in the area of community of practice with quantitative measures. As a result, the study only provides a glimpse at the patterns of online learning behaviors among high school students in general and in a global context in particular. Ultimately, findings of the study are solid cornerstones and references for further studies in the frontier of new schooling with information technology. Above all, the study does prove that PBL provides a unique opportunity to help students practice critical thinking, collaboration, communication, problem-solving, and creativity. It is therefore highly recommended to schools to

adopt PBL when facing challenges of creating innovative pedagogies for the generation of digital natives. The other significant finding of the study is that both PBL and community of practice is a fantastic blending combination and they are tightly dependent on each other. The finding reconfirmed the claim made by Lin and Ma (2011). While practicing PBL pedagogy, therefore, the findings of the study suggests that the best practice of PBL is implemented or conducted in networked learning environments in a global context with vibrant community of practice, since it will result in deeper learning and engaged, self-directed learners.

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