PROBLEM BASED LEARNING: CULTURAL DIVERSE STUDENTS’ ENGAGEMENT, LEARNING AND CONTEXTUALIZED PROBLEM SOLVING IN A MATHEMATICS CLASS

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ABSTRACT

In today’s fast changing world students have to be equipped with knowledge and also skills. The current teacher-student centered settings are unable to produce students who will be adaptive in the workplace. Obtaining a good grade in Mathematics for foundation students who will be undertaking Engineering, Medicine, Pharmacy, Information Technology and Architecture is crucial as this will ensure a place in degree level. Therefore the extent in which teachers deliver their materials is important to make sure that students understand and be able to apply the knowledge learned in their daily lives. These students come from various countries mainly from Bangladesh, China, Yemen, Thailand, Saudi Arabia, Jordan and Syria. This paper presents the findings where Problem Based Learning approach was adopted to teach Mathematics to students who come from diverse cultures. PBL is a collaborative method where it was found from the study conducted that it is a good approach to bring students from diverse cultures together toward a common goal. Students were observed and interviewed in the second semester of their foundation course. PBL activities were conducted in stages and since in PBL, students direct their own learning and work in a group, hence they become motivated, self-confident, and proactive. In the initial stage, there was segregation, meaning that students from the same countries preferred to be grouped together, but as they became familiar with the PBL approach they became more comfortable working with students from different countries. The findings showed that some students have influence on other students in terms of how much and what they learned. It was evident that PBL has positive implications on how student learned, generating ideas to arrange these ideas in a meaningful manner. By doing that, students managed to cultivate skills like problem solving, critical thinking and communication skills. It also helped students to see connections between Mathematics and its application in the real world. This encourages lifelong learning and unity amongst students.

Field of Research: PBL (Problem Based Learning), diverse cultures, Mathematics.

1. Introduction

Mathematical course for foundation students is mainly taught on lecture-tutorial style. Students find it hard to understand the concept and therefore merely memorize the formula and apply them without having a clear understanding of how and when to use them. Therefore, most of these students do not perform well in the exams and most importantly they are unable to relate these mathematical concepts with the real world. Current curriculum and pedagogy practice in classroom are often unable to prepare students to solve problems faced in their workplace and also in their daily life (Akmar SZ, Eng, 2005). Moreover, increase in technological innovations and globalization requires new abilities, knowledge and skills. Therefore there is a need for pedagogical change in the undergraduate programs. (RahimahKadir, 2004; Teoh 2002)

Most institutes of higher learning are now more linguistically and culturally heterogeneous. (Singaram 2010). Students come from different cultural, ethnic, age, social class, educational background, age and
language. Therefore, it is crucial to understand issues pertaining to group composition as this will help educators to deliver their materials effectively hence will have positive learning outcomes. Dissimilarity in cultures in mix groups encourages deviation from important skills needed for cooperation (Dornyei 1997). Dornyei (1997) also stated that these skills such as leadership, communication, conflict management and decision making need to be taught and developed. In another research by (Nieto, 1996), it was found that allowing students to learn in different ways, sharing viewpoints and perspectives in a particular situation based on their own cultural and social experiences, students become active participants in their learning.

However, the cultural differences of the individual students can be a hindrance in their collaboration and also their learning. Culture is comprised of “beliefs, norms, assumptions, knowledge, values, or sets of practice that are shared and form a system” (Rapport and Overing, 2000). So, the different students’ cultural backgrounds affect their participation, motivation, satisfaction and their performance during collaborative learning activities (Economides, 2008). In order to achieve academic excellent, students should have equal opportunity in learning; therefore teachers must take into consideration the students’ cultural aspects.

“A caring adult can make a big difference in the educational outcome of any child that is at risk of experiencing educational failure.”

(Maria Wilson-Portuondo)

According to Ladson-Billings (1995) the important factor for culturally relevant teaching is nurturing and supporting competence in both home and school cultures. In order to develop as a base, learning in this way is more meaningful to the students and as it allows the transfer of what is learned in school to real-life situations (Padron, Waxman, & Rivera, 2002). This is important especially in learning Mathematics because if a student can relate what they have learnt with their daily lives, they will then develop an interest in learning Mathematics.

This study looked into the activities conducted using Problem Based learning approach as a tool for collaborative learning and bringing all students from diverse cultures in working together towards a common goal. The study also presents the students responses to the heterogeneous nature of PBL teams. The findings of this research study serves as a guide lines of what teachers need to consider when bringing multicultural students together in order to facilitate collaborative learning culture in PBL team.

2. Problem Based Learning (PBL)

Problem Based Learning (PBL) is a student centred learning where it emphasis on the process of learning by which the students themselves will come up with the solution and the teacher will act as a facilitator. It works in small groups and deals with real life situations. It enables students to be a part of the learning process by which the students themselves organized their own learning. Problem- Based Learning was first implemented in medical school program at McMaster University in Hamilton, Ontario, Canada in 1960 by Howard Barrows. The reason behind this was because it was found that these students could memorize great amounts of detail but they were not good at applying this knowledge in clinical settings. The PBL method was develop to stimulate the students, help the students to apply their knowledge to solve real life problems and also to motivate them to keep on learning. (Barrows, 1986). The most important is how it helps students to think, create, analyse and apply their knowledge to solve the problem. The key element of PBL is the small group learning which has all the criteria for collaborative learning (Dolmans and Schmidt 2006). The main idea behind PBL is that the learning process starts with a problem, a query that the students want to solve (Bound 1985). In PBL, the problem steers the learning and is posed so that the students discover that they need to learn some new knowledge before they can solve the problem (Woods, 1995). A research conducted by Webb (1996) using PBL on a Mathematics program called Interactive Mathematical Program (IMP) includes topics like algebra, geometry, trigonometry, statistics and probability found that students participated in the inaugural IMP program performed better compared to their peers.
in the traditional high school Mathematics courses. The research also found that students showed great improvement in terms of problem solving skills and quantitative reasoning. According to Jaques (1992), teaching and learning in small groups is an important part of all rounded education.

Students under study here come from various countries, such as Bangladesh, Afghanistan, Pakistan, Saudi Arabia, Egypt, Sudan, Jordan, Yemen and China. They have different ethnic, cultural, language, and education background. Having this diversity can be hindrance to student learning. Since Problem Based Learning is student centered and works in small groups, it gives the opportunity to bring students together. Students can develop a new sense of value through exchanges with people with different cultural backgrounds. Problem-based learning is a classroom strategy that organizes Mathematics instruction around problem solving activities and affords allows students to have more opportunities to think critically, present their own creative ideas, and communicate with peers mathematically (Krulik & Rudnick, 1999; Lewellen & Mikusa, 1999; Erickson, 1999; Carpenter et al., 1993; Hiebert et al., 1996; Hiebert et al., 1997. However, according to Wright and Lander (2003), even as collaborative learning approaches may serve as a platform to bring together diverse students but their efficacy in practice and complications that arise due to the mixed ethnicity needs to be further examined.

3. Characteristics of PBL (Barrows and Tamblyn, 1980)

Problem presented should be a real world situation and ill-structured. It should be meaningful to the lives of the students. Students work collaboratively in small groups and join their efforts to tackle the problem. Staff acts as facilitator and problem lead to the development of problem solving skills. The following is the overall steps taken in PBL session.

- Students were needed to explore the problem given to them.
- Discuss with the group members, share their prior knowledge regarding the topic and elaborate on what they know through discussion.
- They come up with what they need to know where to find the information they need
- Analyze the findings
- Apply their new knowledge to the problem.
- Students then write the solution
- Students then present their solution.
- Students reflect what they have learned.

![Flowchart of the whole PBL process](image)

**Figure 1: Flowchart of the whole PBL process**
4. Problem Statement

Students are lacking in problem solving skills, and are unable to see the connection of what they are learning with the real world applications. This makes teaching and learning Mathematics difficult as students view the concepts learnt in classroom as meaningless.

5. Research Questions

The current study looked into the efficacy of PBL in teaching Mathematics to foreign students. The following two research questions were examined:

1. How does PBL help students from diverse cultures in collaborative learning in Mathematics classroom?

2. What are the students’ overall perceptions on PBL approach in learning Mathematics?

6. Participant and Setting

32 foreign students participated in this study where they were divided into group of 4. There were four phases whereby one week is allocated for each phase. They were then presented with a problem. Each group has its leader and he or she will plan the meeting and looks on the overall procedure. Each group also consists of students from various countries. For example, group one consists of students from Yemen, Bangladesh, Saudi Arabia and China. Four topics chosen were functions, trigonometry, differentiations and matrix. Altogether, duration of four weeks were allocated for PBL. Every week there was one hour scheduled team meeting facilitated by the researcher. A part from this, students were expected to work on their own and in their groups.

7. Procedure

To answer research question 1, “How does PBL help students from diverse cultures in collaborative learning in Mathematics classroom?”, the researcher assumed the role of a non-participant observer. Observation were recorded as field notes and analysed. The researcher also gave out an assessment charts to each of the group leaders. The purpose of the assessment chart is to gain additional information about the process involved. The leader would write down how each student from his group response based on the assessment topics. The observation and assessment chart allowed documentation of the learning dynamics amongst the foreign students. To answer research question 2, “What are the students overall perceptions on PBL approach in learning Mathematics?” semi-structured interviews were used to gain insight into the students’ thoughts as the questions acted as guidelines to elicit responses to the research questions.
Table 1: Group leader assessment form

<table>
<thead>
<tr>
<th>Assessment topics</th>
<th>Student 1</th>
<th>Student 2</th>
<th>Student 3</th>
<th>Student 4</th>
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<tbody>
<tr>
<td>Engagement</td>
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<td>Communication</td>
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<tr>
<td>Inclusiveness</td>
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8. Steps taken in PBL session

The researcher presented the students the problem and introduced the PBL as well. In the beginning stage, where the students brainstormed, each group was given a “Need to know” chart adapted from Stepien, Gallagher, & Workman, 1993 (as attached in appendix I). This helped the students to develop a plan for responding to the problem given.

In relation to the ‘ill-structured” problems, students were needed to come up with learning issues within the context of the problem. A mind map was suggested by the researcher as a tool to write down ideas as they came to the mind and arrange these ideas in a proper and meaningful order.

The researcher elected a leader. The leader then assigned each group member with a particular role.

Student 1: Elected as the leader, proposed when meeting should be held and overlooked the whole matter.

Student 2: Acted as the coordinator, liaised with the team members to unsure the plans carried out were successful.

Student 3: Recorder who took notes for each meeting.

Student 4: took individual notes, gave ideas and participated in discussion. These roles rotated every one week.

In each group, the group leader assigned specific task for each of his/her team members. For example in team 1, student A were ask to get information from the library, student B were ask to get information from the internet, student C were asked to get information from the senior students and students D were ask to get information from the text books and reference books. The next meeting, each student presented their finding to the group. They discussed, debated and argued. The researcher encouraged students participant, gave appropriate feedback to keep the students on the right track. The researcher acted as a metacognitive coach or as a facilitator rather than a teacher. The students assumed greater responsibility for their own learning. In order to get the student thinking, the researcher asked questions such as “what is this problem about?” and “what do we need to find out or know more about?”. The facilitator may intervene if the students are not carrying out their tasks or they are heading towards the wrong direction.

The students, after collecting the information would then meet. In the meeting each of them will present what they have obtained. They would discuss, argue and then come to an agreement of which method is appropriate. In this step students would face some learning issues as of what they do not understand. The recorder would record all the learning issues posed by the team. Students and the facilitator would then go through these learning issues and list down what resources to look for to answer these issues. Students would meet once again with their new findings and discuss together and hence come up with the most viable solution.

Students then will use the accepted method, write the solution to the problem and present their solution in front of the class. Lastly, students would reflect about how and what they have learnt has added to their understanding.
9. Data Collections and Analysis

The data consisted of students’ responses to semi-structured interview data and observation sheet. Semi-structured interviews were carried out at the end of the study, to capture students’ perceptions regarding the use of PBL. 2 students were randomly chosen to be interviewed. The interviewed data were transcribed verbatim, coded and analysed.

Evaluations were done on the assessment report as well as the presentation. The facilitator met the group leader once a week as well as the rest of the team members. At the end of the week, each group presented their findings in front of the class.

The questions in the non-participant observation which was to answer the research question 1 focused on the following aspects:

1) Engagement
2) Good Communication
3) Inclusiveness

9.1 Engagement:

Engagement here means how much a student is committed in learning in group and involvement of the students in a group.

In the initial phase, most of the students were not really sure of how the PBL process works. It was found that few students were reluctant to get themselves involved and students 1 from team 1, student 3 from team 2, and student 5 from team 6 only did what they were assigned to do by the group leader and did not show any interest in interacting with their team members.

Students from teams 4, 7 and 8 showed very good attitude towards learning in a group. They cooperated well in their groups, sharing their knowledge and motivating the team members to complete the task given fast.

However, it was noticed that two students from team 3 asked a lot of questions, showed willingness to learn but only shared their knowledge within each other and not to the whole group. It was noticed that they were from the same countries and they were not very comfortable with working in a group, but as the PBL activities continued to the next phase, they became more accommodative and at the phase 3 and 4 they were already sharing their ideas with the rest of the team members.

Some students in the team 3 and 4 were mature in terms of age, and these students showed more confident and able to persuade other students to work together to complete the task given. These students also had more experience in the subject matter so they were able to contribute, influence and guide the other students in their team.

9.2 Good Communication

Good communication here means how the students exchange information. Good communication can enhance relationship between the students and hence helps to improve teamwork, problem solving and decision making. It combines skills like attentive listening, nonverbal and managing emotions.
In the first phase and second phase, the flow communication was not that encouraging for 3 students from team 2 and 3 as they did not show up for the unsupervised meetings and only showed up for supervised meetings. The rest of the team members were present and showed positive attitude towards learning.

In the second phase, students 3 and 4 from team 3 got into an argument as student 3 was dominant in nature and refuse to listen to ideas given from student 4. However the matter was resolved as the other team members manage to persuade, negotiate and finally came to an understanding.

In the phase 3 and 4 however, these two students showed no resistance in working together. Students 3 became more tolerant and listen attentively whenever the other members talk. Overall the other students interacted well as they were eager to finish task on time.

It was observed that the students were comfortable communicating in their native language, but on and off the researcher reminded and encouraged the students to use English Language as English is the medium of study in the university.

The steps in PBL approach helped the students to get together and communicate face to face among the team members.

**9.3 Inclusiveness**

Inclusiveness looks into creating a pleasant environment where everyone can work together irrespective of race, colour and ethnicity.

At the initial phase there was segregation among the students. It was observed students prefer to group with students from their own countries.

PBL, collaborative learning takes place, and this creates a familiar atmosphere which brings them closer. Students are aware of different cultures and therefore they can communicate appropriately and sensitive ways. This was evident in students in team 6, 7 and 8 as they showed great deal of respect to their team members. They were very persuasive and influential as well.

**9.4 Semi-Structured Interview Analysis**

The questions in the semi-structured interview which was to answer the research question 2, focused on the following aspects: Two students were randomly chosen from each team at the end of phase 4. A total of 16 students were interviewed.

1. In which phase did your contribute?
2. Were you shy in the beginning, if so did your group members encourage you?
3. Has your communication skills improve from one phase to another?
4. How you felt in working in mix group?
5. In what way PBL approach help you in learning Mathematics?

In response to the first question, 7 said they contributed in phase 3, 2 in phase 1, 5 said in all the phases, 2 said phases 3 and 4. Only 4 of the 16 students said that they were shy in the beginning but all of them manage to overcome this with the help of their team members.
Sample of responses from students in relation to question 1.

Excerpt A:

*I contributed most in phase 3 because I more know about the subject compared to the other topics. I study in my country and now I can solve this problem.*

Excerpt B:

*I contributed in all the phases as I believe that that’s the way it should be. I looked up in internet and the reference books and I shared what I found with my friends. This way the problem can be solved fast.*

In response to the second question;

Only 4 of the 16 students said that they were shy in the beginning but all of them manage to overcome this with the help of their team members

**Samples of responses from students in relation to question 2.**

Excerpt C:

*Yes, I very shy and I don’t know much about the topics. I study but do not know how to express or explain. But two of my team members are older so they told me don’t worry. Slowly I improve on my confidence and also my speaking.*

Excerpt D:

*I was not shy as all my team members cooperated well together. We motivated and encouraged each other. We wanted to finish the problem fast.*

In response to the third question

12 students answered yes, that they have improved in their communication skills. They learnt to be better listener and have more confidence. 4 students however said the otherwise and did not get involved much in the interaction among the team members.

**Sample of response from students in relation to question 3**

Excerpt E:

*I surely improved a lot in my communication skills. I know the proper way to ask a question and also the correct way to associate with people. I also learnt that you must listen carefully when your team members are talking, in that way we can learn and share new information together.*

In response to the fourth question;

14 students find that working in a mix group has benefited them. The PBL steps which involved, researching, brainstorming and coming to one understanding has brought these students closer and they have bond irrespective of race, colour and ethnicity.
Samples of responses from students in relation to question 4

Excerpt F:

I am from Chad and in my group students come from Sudan, Afghanistan, and Yemen. It was an interesting experience from me as I noticed that they have different strengths and some are more exposed to the subject area than me. One of my team mates showed me a different approach that he has learnt in his country in solving matrix problem. I really learnt a lot from them.

Excerpt G:

It was enjoying as I got to know people from different countries. It was a colourful experience. I got a lot of motivation from my team mates. It was less stressful too.

In response to the fifth question; 10 students said that they have improved in problem solving and critical thinking skills. 2 students mentioned that it was a time consuming approach and problems could be solved by looking up in the internet for the solution while the 4 of them said that it was a good way to learnt Mathematics as it was interesting and the interaction among the team members allowed them to gain more knowledge. In this way it made more sense to them. They managed to see the connections between Mathematics and its application to their daily life and this motivated the students to take up an active role in learning.

Samples of responses from students in relation to question 5.

Excerpt H:

I wanted to contribute in my group discussion, so therefore I had to read a lot. In the group you do a lot of brainstorming and sharing session. In this way not only we gain information but also improve in our problem solving skills and critical thinking skills.

Excerpt I:

Good approach. Now I can see the application of Mathematics in our lives.

Excerpt J:

Before this, I don’t know why I must learn Mathematics; I always thought it waste of time. But now I can see where and why I need to know Mathematics.

10. Discussion

Problem Based Learning (PBL) creates an environment or platform where students from different cultures and background can come together and share their views. Students learnt to respect their team members as they interact. It was evident here that the students’ contribution in the PBL steps to some extent is influenced by their cultural background. However, there was segregation within the groups at the beginning phase. A study done by Wright and Lander (2003), noted that this segregation may be due to “in-group’ factor which is characterised by members who share common interests and goals. It showed that students might not feel comfortable when put together in a mix group.
Students cultivated various skills as the PBL approach progressed to next phased. The skills here include, communication, leadership, negotiation, listening and also persuading. Good communication is extremely important as it can enhance relationship between team members and therefore it improves teamwork, decision making and problem solving. It helps these diverse groups to understand better and make decision based on what they have understood.

The study also found that how much a student participate in a group discussion depend greatly on their knowledge level on the subject, ability to speak in front of others and willingness to work in a group. PBL encourages the cultivation of knowledge as it requires the students to brainstorm and do their own research to gain extra information. By teaming up in groups and in the sharing sessions, students get new perspective as this it was evidence in this study.

As a conclusion the approach teachers use in delivering their materials is important and determines a large extent of whether or not a student is able to grasp the concept and does it make sense to him. Teachers has to bear in mind that factors like race, ethnicity and education background can influence how learning take place in PBL teams. Therefore, teachers must find suitable ways to overcome these barriers to enhance interactions between students in order to make PBL successful. It is a good approach in teaching Mathematics as students will be able to see the connection between Mathematics and real world and this can motivate them to lifelong learning.

References


**Appendix I**
<table>
<thead>
<tr>
<th>What Do We Know?</th>
<th>What Do We Need to Know?</th>
<th>What Should We Do?</th>
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<td></td>
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