

An Appropriate Technique of Facilitation Using Students' Participation Level Measurement in the PBL Environment*

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Students' participation in the PBL group discussions has always been associated with the role of facilitators, who are responsible for the effectiveness of tutorial sessions. Facilitators should be aware of how their students participate in small-group discussions and thus adopt suitable facilitation techniques to encourage active student participation. However, determining students' levels of participation in a PBL small-group discussion is a very subjective matter. As a result, it is difficult to assess the effectiveness of particular techniques or approaches that are used for facilitation. Therefore, the objectives of this paper are as follows: first, examine students' participation in PBL small group discussions; and second, propose an appropriate technique of facilitation, with respect to the group members' participation levels. Participants for the study comprised the first-year polytechnic electrical engineering students, who were undergoing ten-week PBL according to the fourteen-step procedures. These students participated in small-group (four to five members) discussions to solve five electrical engineering problems in a two-week block period. The students' participation was observed and videotaped, as well as getting students to use a fixed reflective journal to record their thoughts after attending all the tutorial sessions. Our findings revealed that four classifications can be used to explain students' level of participation namely, behaviour (active-passive), oral (silent-talkative), group skills (Excellent-poor), and confidence (high-low). These classifications can be grouped into several combinations in order to explain the students' levels of participation in small-group PBL discussions. Premised on the findings, several suggestions are proposed to develop a facilitation technique: to create an environment conducive to discussion sessions and encourage active student participation.

Keywords: problem-based-learning; facilitation; students' participation; engineering education; electrical engineering

1. Introduction

A facilitator's prescriptive tasks in a Problem Based Learning (PBL) environment require a long list of actions to be identified. Facilitators should apply their knowledge and skills of a subject matter expert or procedural expert in tutorial classes, especially in group discussion sessions [1]. Among the important tasks, a facilitator is to guide students throughout the process of learning in order to achieve the course learning objectives. In addition, a facilitator has to deal with group dynamics, fostering a suitable climate for collaborative learning [1]. In particular circumstances, a facilitator is responsible for resolving team conflicts through diplomatic and negotiation skills [2, 3]. One major responsibility of a facilitator is to ensure an appropriate level of participation and the optimum use of resources in order to increase group effectiveness [4].

Determining students' levels of participation in a PBL group discussion is very subjective, especially in the engineering context. Previous studies agreed that measuring participation can be done as a group property but not as an individual count [5]. Some studies have examined individual participation rates in relation to communication of influence or persuasion of members of a team [6]. In fact, some researches propose a matrix for measuring an

individual's participation [5] using rubric, questionnaire, and informal self-assessment [7]. It is argued that the level of participation can be observed from the pattern of interaction and contribution of members in a group, which are actions or non-verbal language/communication indicating an individual's behaviour (active-passive), oral ability (silent-talkative), group skills (excellent-poor), and confidence (high-low).

Previous authors pointed out that behaviour, oral ability, confidence level and group skills are associated with one another; the combined effects of these four factors influence an individual's participation in the group discussion [8]. A student's active or passive behaviour in participating in group discussions has been explained in the Model of Learning and Teaching Styles [9]. In addition, based on the psychodynamic theory, when only two of all group members have mutual respect and support, the group is inactive [10]. When a student actively participates in a discussion session, the student talks, moves, and reflects on the subject matter; when a student switches to passive mode, the student watches and listens. However, a student's actions of talking, moving, and reflecting within a group might end up in disaster without proper group skills. Therefore, an appointed leader is crucial and must function as an individual who

coordinates a discussion orderly and effectively according to procedures [11]. In order for everyone to attain success of learning, a group should comprise members with understanding of content matter and good communication skills; they should also demonstrate a high level of confidence in presenting views and opinions in a discussion session.

Using PBL as a platform, a facilitator is the most important person who can influence students' participation in a group discussion. A previous author proposed a facilitation method based on students' capability [12]: minimal, moderate, or aggressive guidance is provided for students depending on the maturity levels of students. However, it is difficult to prescriptively define a set of procedures for effective facilitation and stimulation of active participation according to maturity levels, since students have diverse backgrounds and experiences. Existing models of facilitation such as the pyramid model of facilitation [13] are sometimes difficult to be applied in the practical group environment, especially in the engineering education context. Additionally, specific methods of facilitating PBL group discussion sessions are dependent on the individual skills of a facilitator.

In the context of PBL small-group discussions, a facilitator is the only person who is responsible for how the students participate in small-group discussions, and how to adopt suitable facilitation techniques for students' active participation. However, determining students' levels of participation in a PBL small-group discussion is very subjective. As a result, it is difficult to determine the effectiveness of particular techniques or approaches used for facilitation. Therefore, this paper firstly examines students' participation in PBL small-group discussions, and secondly proposes an appropriate technique of facilitation, with respect to the group members' participation level. The findings reveal a construct for students' participation level and the authors propose a technique for facilitation of the first-year engineering students in the PBL small-group discussions.

1.1 Engineering education: small group facilitation

According to [14], the group size for an engineering education context requires five to six members for the first year students. Some authors propose that an ideal number of a small group should comprise four persons [15]. In deciding on an ideal number of a group, a balance between the size of an engineering project and the time frame must be considered. The group should become smaller, limiting the number to two to three members upon approaching the final year [14]. An ideal group size is important to allow active participation within the diversity of

members in a group. Learning becomes more interesting, so that they enjoy participating and are intrinsically motivated [16].

Learning in a small group is one of the properties in PBL approach; it facilitates learning from basic knowledge to the higher level of application. While solving electrical engineering problems, students typically are engaged in analytical, technical, and practical activities [17]. According to [18], students in engineering courses should be given an opportunity to gain a learning experience that allows them to construct deep conceptual knowledge. In this case, some problems may require students to know the basic concepts to hold meaningful discussions, while some other problems may require students to be involved in practical work such as circuit simulation or laboratory experiment. These learning processes are important in order for students to gain understanding and appreciation of a subject matter. Interaction in a small group elevates learning to a higher level, encompassing application, analysis, and synthesis [11, 19].

In this context, stimulating effective interaction and active participation might become an issue for small group learning; it requires changing of roles, from teacher to facilitator. In [20], the researcher suggests four types of facilitation, which are facilitation according to the product-based, process-based, principle-based, or control-based. Each type has a different approach depending on how facilitators put themselves in a situation, as a team fellow learner, as a group trigger, or as a consultant. There are many techniques and approaches that can be used to produce an effective facilitation; however, choosing one that suits the students' needs requires careful consideration.

Therefore, an ideal facilitator should have two sets of skills [1]. Firstly, the facilitator must possess skills relating to PBL process and procedures, such as dealing with group dynamics and fostering suitable climate for collaborative learning. Secondly, the facilitator must be equipped with skills to stimulate students' metacognitive ability, such as probing, questioning, provoking, and any other methods that can encourage students to think creatively. In certain circumstances, the facilitator must be capable of resolving team conflicts through diplomatic and negotiation skills [2, 3].

2. Methodology

The data reported in this paper are a subset drawn from an experimental study among engineering students. This research project attempts to draw a comparison between the effects of PBL and Traditional Learning Approach in terms of knowledge acquisition, critical thinking ability and intrinsic

motivation. While the comparative study provides a major finding from the quantitative data, the combination of several qualitative data yields another significant finding. The qualitative data of the study consist of an observation, video data, reflective journal, and field notes.

2.1 Research participants

Participants comprised 27 first-year undergraduate students from the electrical engineering course in one of the polytechnics in Malaysia; 24 of them were male and the remaining three were female. These students had undergone ten weeks of PBL tutorial sessions in one of the compulsory modules, namely Electrical Technology.

2.2 Qualitative data collection

Data field notes were collected by a facilitator (the third author) during the PBL group discussion sessions, in order to capture the right and close observation of students' participation. The field notes were recorded according to descriptive and reflective methods [21]. In the descriptive method, the observer records the natural setting, actions and conversation taking place in the tutorial sessions. In reflective method, the observer records ideas, thoughts and concerns based on the observation or reflection of events taking place in the tutorial sessions.

In order to support field notes data, the group discussion sessions were videotaped. A video camera was set up before the discussion sessions started, in order to capture students' participation, especially non-verbal language/communication. The video data were used to support the field notes jotted down by an observer regarding students' participation in PBL group discussions (behaviour, oral, group skills). The writing of reflective journal was implemented for each student at the end of the session (one complete cycle of PBL procedures). The purpose of the reflective journal was to capture the psychological role (confidence) of students' participation in the PBL group discussions; the journal contained specific questions such as "what is the most motivating thing in PBL session" and "what is the most frustrating thing in PBL session".

2.3 Brief notes on PBL tutorial session

The instruction was based on the 14 steps of PBL procedures [22]. Briefly, during the first meeting, students were divided into groups according to previous test results such that higher-score and lower-score students were evenly distributed (heterogeneous group). A total of seven groups were formed: six groups each with four members and one group with three members. Members of each group

were then asked to appoint a leader and they were briefed on the PBL procedures. The discussion sessions were held in the class with proper arrangement of tables (by group), chairs, whiteboards; students were free to move around within their respective groups and use any tools for discussions.

Students were given a series of five PBL subject-focused problems (subject-centric) during the 10-week PBL tutorial sessions. Each problem required a two-week block of time to complete one cycle of PBL procedures. In the two-week block, it was compulsory for students to attend two tutorial sessions. The gaps between these tutorial sessions were dedicated to students' self-directed learning. The first session was tailored for problem delivery and group brainstorming, while the second session was devoted to group discussions (decision-making) and presentation. In these sessions, the facilitator guided students through the problem solving process according to the floating facilitator concept.

An assessment was held in the second week (in each cycle) that involved major activities, including information sharing, assessment, and feedback. The assessment was based on the evaluations carried out by the students and tutor/facilitator, which used similar rubric rating scale and grading forms. The main focus of the assessment in PBL was to measure the effectiveness of the process skills, as well as the quality of the final product.

2.4 Data analysis

At the end of the 10-week tutorial sessions, field notes of 20 sessions as well as 135 pages of fixed-reflective journals were analysed. Data from field notes and students' fixed-reflective journal were transcribed digitally into a matrix form; these data were then analysed and synthesised thematically. The videotapes were repeatedly played and watched; the data obtained from these playbacks were used to double check students' behaviour, oral, group skills, and confidence or to gauge students' general participation during the discussion sessions.

3. Findings

Several repeated patterns (based on themes) of interactions were identified in order to understand students' participation during the discussion sessions. These patterns include the students' behaviour (active-passive), oral ability (silent-talkative), group skills (excellent-poor), and confidence (high-low), as described in Table 1. These patterns were set up as a base for critical comments and discussions regarding students' participation during the PBL group discussion sessions.

Table 1. Themes from data matrix of extracted field notes and fixed reflective questions

Type	Descriptions
Behaviour <i>Active-passive</i>	<ul style="list-style-type: none"> Some group members actively participated in the discussion activities. They moved and reflected on one another's responses as indicated by non-verbal language/communication. Some group members passively participated in the discussion activities. They moved less, provided minimal response and did not reflect at all (during the first and second PBL cases).
Oral <i>Talkative-silent</i>	<ul style="list-style-type: none"> Some group members were talkative. They touched on relevant and irrelevant topics of discussions. Some group members were quiet for at least 10 to 15 minutes during the discussion sessions.
Group skills <i>Excellent-poor</i>	<ul style="list-style-type: none"> Group skills were excellent for some groups. Procedural discussion was observed: chairman, secretary and contributors. Group skill was poor for some groups. No procedural discussion was observed.
Confidence <i>High-low</i>	<ul style="list-style-type: none"> Some group members have high levels of confidence in action, behaviour, communication, contributing ideas and proposing solutions. It was generally indicated by facial expressions (supported by reflective journal). Some group members have low levels of confidence in action, behaviour, communication, contributing ideas and proposing solutions.

Table 1 shows the pattern classifications of students' behaviour, oral ability, group skills, and confidence level during discussion times in the PBL group tutorial sessions. Based on these classifications (construct), they can be used to identify students' participation level in a group discussion session. Since each group may differ according to students' characteristics, these classifications can churn out several combinations as indicated in the matrix form in Table 2:

During the PBL process, students work in several discussion sessions; a facilitator may choose one construct for each session as the main learning outcome. In this example, the first two descriptions focus on students' behaviour, while the next two focus on students' confidence level. The descriptions of construct combinations are presented as below:

Active and talkative group: A number of groups were active during the discussion sessions (on topic or off topic); the members of these groups were talkative persons. Talkative students participated in the discussion sessions and got along well with other members. Particularly, the PBL problem was discussed vigorously from many possible angles, and several possible solutions were also identified.

These active participation and spontaneous responses were reflected in excellent presentations with good content and proposals with minimal errors. Interestingly, some students of certain groups who were identified as quiet persons appeared to be contributors of ideas.

Passive and silent groups: This category usually has two distinct types of groups exhibiting different characteristics. Firstly, a successful group with passive members; the group was led by quiet but brilliant or hardworking members. Secondly, a failure group; some members did not cooperate and some other members were silent participators who seldom talked [8]. Two occurrences can be observed in the successful group (first case): first, some students kept silent and only talked when they were prompted by other members; second, some students kept silent and only listened to others for the initial 10 to 15 minutes. In the starting PBL group discussion, it could be observed in both types of groups that several students were shy and felt awkward to participate in discussions, especially when female members were present in the group.

High confidence and poor group skills: Several groups were observed to have high levels of con-

Table 2. Matrix of constructs of students' participation

		Behaviour		Oral		Group skills		Confidence	
		Active	Passive	Talkative	Silent	Excellent	Poor	High	Low
Behaviour	Active			√					
	Passive				√				
Oral	Talkative								
	Silent								
Group skills	Excellent								
	Poor								
Confidence	High						√		
	Low					√			

confidence in conducting group discussions. However, the members lacked group skills in order to have an effective discussion session. Members contributed ideas and the discussions appeared organised and procedural, but no one took down notes.

Low confidence but excellent group skills: Several groups were observed to have low levels of confidence as indicated by their facial expressions, but the members had good ideas and skills in problem solving. A member of a group was actually brilliant and creative; this was reflected in the many ideas suggested, as soon as the discussion started. The members were hesitant to kick off the discussion of the topic given at the beginning. The group wasted quite some time before some members started the ball rolling in the discussion session.

Given this matrix of construct in observing students' participation in the PBL group discussions, a particular group may be associated with more than one column of construct. For example, passive and silent, passive and poor group skill, passive and low confidence; in this case, behaviour (passive-active) is the main concern of the particular group's activity.

4. Discussions and recommendations

Literature suggests that the skills of facilitators are one of the three main input variables that influence the tutorial group process, which in turn determines cognitive and motivational outcomes [15]. It is believed that by improving the group process, individual participation will also increase; the key is that facilitators must play their roles appropriately according to the nature of individual groups. In considering these constructs, one might argue that variables such as student characteristics will substantially affect the amount of self-study and the level of students' participation in learning. However, it must be noted that without a facilitator's guidance, it is doubtful that group discussions can be effective since individual participation is minimal or perhaps none at all.

Premised on these findings, four constructs are derived based on the dynamics and variety of group nature and action in the PBL group discussion sessions as well as existing literature. Basically, several possible combinations can be generated based on the four constructs, but only four major combinations are highlighted for discussion in this paper. Therefore, several recommendations for facilitation techniques are proposed, especially for those who are practising the concept of floating facilitator, which is mainly based on the group nature.

Generally, for the active and talkative groups, the identified quiet individuals can be put together with those who are more talkative to encourage commu-

nication and ensure effective discussion sessions. The quiet individuals appear to be good critical thinkers because they are capable of debating ideas proposed by other members as well as facilitators. This does not always happen because the quiet individuals sometimes are not in the same groups as talkative members. However, in order to maintain the level of control, autonomy as well as to include social aspects of students' learning [15], facilitation techniques are proposed to deal with participants according to the identified group nature as defined above.

Active and talkative group: The facilitator must give the top priority to frequently monitor discussion sessions and guide participants to move along the right path. Naturally, the purpose of facilitator intervention is to improve the way participants identify problems and solve them [23]. The actions of facilitators must serve to trigger students' metacognitive ability, such as probing, questioning, provoking; they may employ other methods that can stimulate students' thinking process [1]. However, it is suggested that the level of facilitator intervention be kept to the minimum to avoid disrupting the flow of group discussions.

Passive and silent group: The facilitator should provide aggressive guidance to excite members so that the groups can take off with warm and lively discussions. In this context, aggressive guidance means to encourage collaborative learning among members within a group, inside and outside of the tutorial class [15] in a more frequent manner. In the tutorial class, the facilitator can promote warm and lively discussions amongst group members by injecting a hot topic, a controversial issue, or a particular concern relevant to the problem in hand. Another role of the facilitator is to monitor participation of individual students in brainstorming sessions. Outside the tutorial class, the facilitator should encourage students to have independent group discussions and self-study sessions; this will provide an opportunity for group members to speak and contribute ideas.

High confidence and poor group skills: The group requires less help from the facilitator to start the discussions. The facilitator's role is limited to suggesting members of the group to be chairman, secretary, and contributors in the discussion session. The facilitator has to monitor the discussion at the beginning before leading the group to work independently. In [4], the researcher highlighted the necessity of group members to function at appropriate levels of participation and the proper use of resources in order to have effective group discussions. Minimal guidance from the facilitator is needed for this type of PBL group.

Low confidence but excellent group skills: The

group members require some ideas from the facilitator to start the discussions. Everyone is hesitant to contribute ideas although they have been thinking so much about the topic given. The main issue is that students are less confident to speak up. According to [23], group effectiveness can be increased by creating a discussion environment that is substantively neutral. It is suggested that the facilitator acts as a fellow learner within the group to create an informal discussion environment. The discussion in this case should be continuous, similar to normal conversations and chats with friends.

5. Conclusion

The participation of engineering students in PBL group discussions has always been associated with the role of a facilitator, who is responsible for the tutorial sessions to be conducted effectively. The facilitator has a crucial job to promote fruitful group discussions and to stimulate the minds of participants to think creatively, according to the dynamic group nature. Under the facilitator's proper supervision, participation of individuals in the discussion sessions can be increased; the interaction between members of a group will also become more lively and enjoyable, and this in turn will lead to a higher level of learning. In this study, students' participation in the group discussion is identified based on the proposed constructs measurement, so that the facilitator can adopt suitable facilitation techniques to encourage students to engage actively in the group. A facilitator should identify the main flaws of a particular group in terms of students' participation such as passive behaviour, silence, poor group skills, and low confidence. For a group to function smoothly, several steps are essential such as allowing a group to appoint a leader that rotates for every single project and letting students decide who the first leader is. It would be helpful too for facilitators to monitor groups every 10 to 15 minutes; the aim is to create a friendly environment, impart group skills, and update the discussion progress every 10 to 15 minutes. Facilitators must also emphasise the need to arrive at clear findings; this will guide the discussions along the right path and prevent subject digression.

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