A METHODOLOGICAL ARGUMENT FOR DESIGNING ASSESSMENT OF STUDENTS' TEAMWORK IN PROBLEM-BASED LEARNING

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ABSTRACT: Problems-based learning (PBL) uniquely attempts to scaffold praxis from conventional pedagogical approaches to practice-based learning. With a particular focus on construction education, this paper reviews a range of perspectives on the applications of PBL in different disciplines where it has been applied. It also draws a line between assessing students' group work and assessing students' teamwork. In the end, existing models on group-work assessment are adapted in line with the practice of teamwork in the construction industry.

Keywords: *Assessment, Construction, Constructivism, Problem-based Learning, Group-work, Teamwork*

1. INTRODUCTION

Literature resources on knowledge construction span a wide range of pedagogical approaches; constructivism, discovery, experimental, inquiry-based and problem based learning. Each of these approaches had been applied in different disciplines and conclusions have been drawn regarding which method constructs knowledge better than others in a particular situation. Similarly, several studies have explored which method drives and/or supports the efficacy of learning in generating certain expected outcomes in specific learning conditions where other constructivist approaches are not likely to perform in the same manner.

A recent study by [1] categorized learning conditions as minimally guided – a situation where learners actively influence learning, rather than solely depending on information presented to them; and direct guidance – a situation where leaners rely only on what is presented to them. Many practice-based disciplines, including architecture engineering and construction (AEC), medicine, nursing, policing and liberal arts have embraced problem-based learning [2, 3]. Although, PBL has been interpreted in these disciplines in slightly different ways, there is a wealth of evidence in literature to establish its positive impact on knowledge constructivism in these disciplines [4, 5].

PBL promises a wide range of attributes that enable students solve complex problems in real-life situations. Rather than depending on basic instructional materials in a teacher-centered approach, students under PBL environments engage in learning activities that trigger deep meaningful learning, when they want it and how such approaches best address their situations. PBL environments could include active learning (where learning is based on instructional methods), collaborative learning (where students work together in groups to achieve learning outcomes), cooperative learning (where students work in groups but they are assessed individually) and inquiry learning (where students focus on content and discipline specific collaborative learning and could be assessed as a group and/or as individuals).

It is a common knowledge that the efficacy of learning is engrained in the efficiency of assessment. Whether PBL performs better than other pedagogical methods in practice-based disciplines, the main determinant is how specific learning expectations are assessed and what students got out of such assessments to influence their practice lives. Group-work and teamwork does not necessarily mean the same thing to every discipline. This

paper conceptualizes the ideals of teamwork in the construction industry; and attempts to develop a descriptive model for assessing teamwork in construction education.

2. GROUPWORK VS TEAMWORK

Studies such as [6, 7] have indicated how engineering students are assessed in group-work. In the construction industry however, teamwork is not quite the same as group work; group-work is learning or working within a single discipline context, while teamwork is multidisciplinary. Although, literarily, most dictionaries consider a group and a team as synonymous, in construction disciplines however both words are not necessarily synonymous. By illustration, it is one thing for a group of professionals in the same discipline to work well with each other and achieve desired results; it is another thing for a professional to work in a team of professionals from non-related disciplines within the same or different industries and achieve similar results as in a monotonous group.

According to [8], team members collaborate to share integrative data while cooperative groups (as defined above and supported by [6]) work together to meet specific discipline concentric goals. In the end, the transaction bond between team members is covalent, robust, objective and multidimensional; whereas in group-work, data sharing could be simplistically cooperative, ambiguous, unable to drive team success, and counter-productive. Although, it is very common that professionals work together both in groups and teams; students' leaning on the difference between the two should not be compromised. Paradoxically, as teamwork and group-work are not quite synonymous, most knowledge resource on group-work in PBL has failed to consider disciplinary variability as per how teams are formed in different work place scenarios.

In the construction industry, a project team may include a range of different disciplines – Architects, construction managers, project managers, structural engineers, quantity surveyors, land surveyors, cost planners, plumbing engineers and electrical engineers. The goal of the project is for professionals from these disciplines to drive project goals collectively as a team, not necessarily of a group of professionals with fragmented commitments. Previous studies, such as [9, 10] have further conceptualized teamwork in the construction industry, and concluded that employers are more likely to be impressed with the performance of a graduate as a team player rather than a clever lone performer. However, as these professionals are groomed from fragmented disciplines, for PBL to fulfill its promises, learning and knowledge assessment in teamwork must transcend the ideals of group-work.

3. PREVIOUS STUDIES ON GROUPWORK ASSESSMENTS IN PBL

There are different ways of assessing students' learning. An exposition by [11] identified students' assessment methods as summative (instructional-based) and formative (negotiated around robust feedbacks) assessment methods. Other studies have included diagnostic (where a student is tested to determine his/her competence to take a course) and negotiated assessment (where a student contributes to what he wants to be assessed on). Of all these options, formative assessment methods, and most recently negotiated methods, are mostly used in assessing students' performance in PBL. An empirical construct of how PBL groups are formed and assessed have been outlined by [12]. This, according to the author, includes group formation, tasks definition, monitoring of group activities, peer assessment and the finality of individual performance either by using formative, summative or both approaches.

The process model by [12] on how group-work should be assessed has been generically applied in different disciplines [13]. However, there are numerous reports on how students' learning objectives have been frustrated by this model [4, 14]. Where PBL learning environment is composed of students who are learning from a distance, face-to-face meetings have been impossible. Even when internet breaks this barrier, distance learners are on-the-job learners; their commitments to jobs, families and other issues have often overpowered their contributions to the group-work as and when needed.

There are also the problems of group compromise and disequilibrium in what each student contributes to the group. This is because students' knowledge, industry exposure and capabilities on the different subjects are not

equal. It is also unclear how contributions to group-work are assessed. Is it by volume, frequency of interaction, cumulative worth of sense each candidate contributed to the group in terms of criticism, leadership, directions, critical reasoning or solely on the quality of the group's final report?

Moreover, it is inconclusive whether or not it is fair for each candidate to be assessed poorly because a member of his group has frustrated the performance of the group and whether a not it is fair to make how a group works a burden for a particular role player in the group or the whole team? On the other hand, disputes arise in teams. Research is inconclusive on how these issues are resolved and students get the better out of the situation. With these enormous risks in the design of group-based learning, it is reasonable that both teamwork and group-work learning and assessment models require more constructive efforts.

4. PROCESS MODEL FOR TEAMWORK ASSESSMENT

The anatomy of assessment methodology for teamwork is indicated as Figure 1. Basically, there five components in setting up and assessing students' teamwork, viz; course design, team formation, role distribution, moderation and monitoring of collaborative activities, team mentoring and tutoring, and assessment of learning activities. The breakdown of secondary descriptors for these items is indicated below:

Course Design

An effective course design starts with making learning requirements clear to the students; needless to affirm that assessment objectives must strongly correlate with expected learning outcomes. Therefore, when students enroll for a PBL course where teamwork is tested, they are thoroughly informed on the course requirements and the roles they will play to achieve course completion. Moreover, problem scenarios upon which their assessment will be based must be relevant to their learning expectations and set-up in such a way that appropriate capabilities are tested.

Team formation

Students can be arranged into teams randomly. This is because team members, except an executive project manager, often have limited powers in determining who they work with [15]. Moreover, the number of people in a team depends on the number of disciplinary roles in each specific project scenario. Where students are allowed to interact before teams are formed or recommend who they are willing to work with, personality bonds between these actors may make or jeopardize the goal of the team project. As a matter of fact, there is no major evidence in literature to conclude that students' contribution to team formation improves students' performance.

Team formation can also be based on workable psychometric models. Students could be asked to fill questionnaires on their personality traits such that only those with compatible qualities are teamed together. When complementary traits are cumbersome or unavailable, students could be motivated to take up adaptive roles and work in team's interests. Psychometric models on the selection of professionals for construction projects have been developed by [16]. Hence, the ability of a student to take up adaptive roles will definitely be an added advantage – this has been underpinned by previous models on multi-skilling in the construction industry [17, 18].

Role design and distribution

Based on any project scenarios that have been chosen for students to be assessed upon, each team player must have distinctive roles. According to [19], this has a long way to go in influencing how individuals perform in a team and how they are subsequently assessed. Some of the directions indicated by these authors include the fact that team members can pick a role voluntarily or be assigned one.

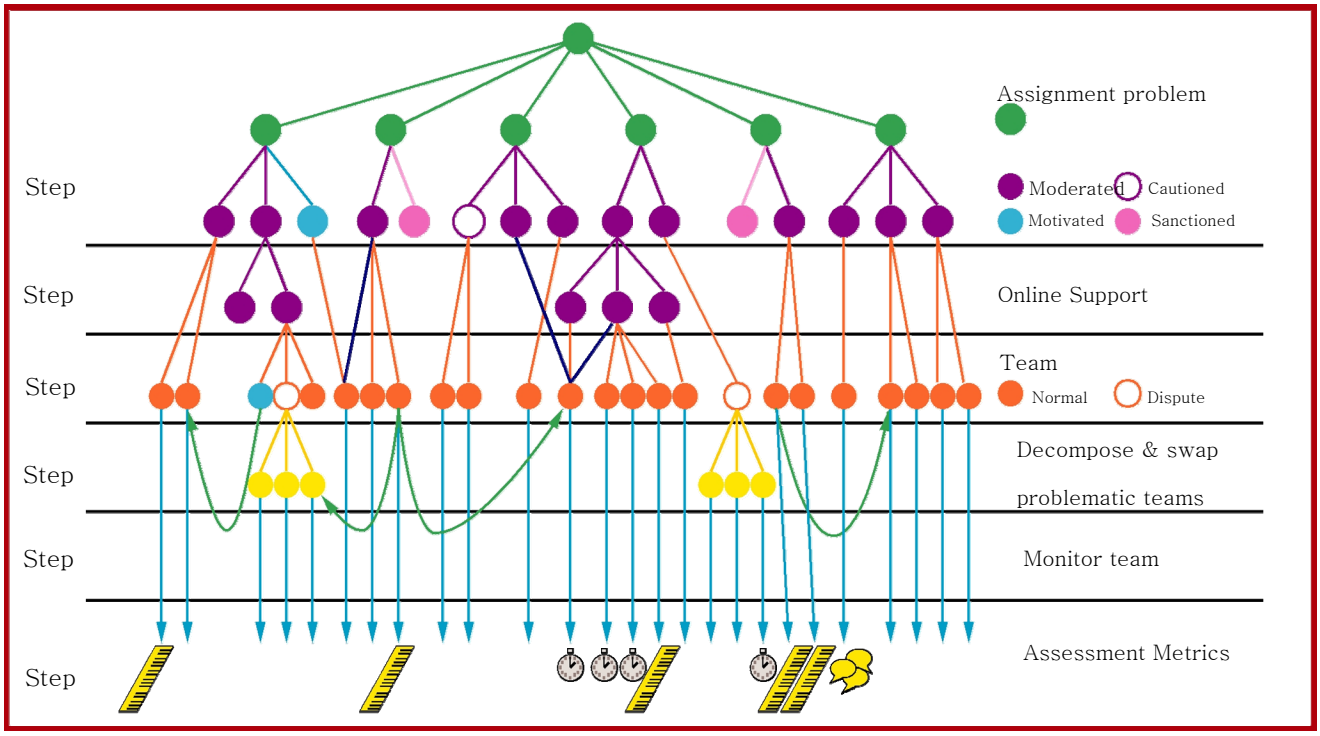

Figure 1: An anatomy of assessment methodology for teamwork

Roles can also be rotated. In the course of learning in this way, the target is to ensure that students come out team spirit experiences like communication, leadership skills and social tolerance attributes.

Designing team roles depends on the nature of project scenarios and could be different from discipline to discipline. Generally however, role attributes could be primary (based on different discipline practices in the problem scenario) and secondary (based on team maintenance roles). For example, for an assignment on infrastructure development, students could be assigned primary roles in architecture, structural engineering, health and safety, services engineering, estimating, and construction planning and management. On the other hand, secondary roles could include that of:

- *Team facilitator,* who moderates team activities like meetings, data sharing and serves as the main contact person for the team;
- *Team scribe/recorder,* who manages team's materials and records, presents a report on team activities per week, and co-ordinate team submissions for the course;
- *Team reporter,* when oral presentation becomes necessary, this team member can represent the team to discuss how decisions were made and how each problem was dealt with;
- *Team researcher/resource procurer,* who procure research materials, additional readings, liaise with data sources and external supports for the team. The member can also handle Standards' compliance procedures of the team.
- *Team time keeper,* who makes sure all team players work to time.

Moderation and Mentoring

When each team member choses the primary and secondary roles, it the next reasonable thing to do is to support the activities of the teams. However, there are instances where a team member lacks the willingness to perform either the primary or secondary (or both) roles. If this does not happen in the beginning, it could happen in the middle of the course – students could lose interest in

team activities as the course progresses, there could be in-fighting and frustration as a result of incessant sabotage, isolation or misguided actions of a member of the team, among others.

There few ways of dealing with team problems:

- *Motivations:* Where a member of a team has little or no motivation to contribute to teamwork process, and this can dis-incentivize the team, such members can be considered as a special case by the course coordinator. Asides, Right from the beginning of the course, there should be adequate support for all teams in terms of mentoring and consistent interaction with reputable practitioners in the industry who are able to share their experiences in teamwork. This will help students value their expectations more and stay committed to their course.
- *Control Actions:* Where someone's action is tantamount to the failure of the team – maybe due to high handedness, counter-productive controversies and other similar vices; the course handlers and coordinator should reserve the right to invoke certain steps of action. This could include, removing and/or swapping members of different teams or forming new teams all together. There can be a set of rules on team etiquettes, possible misconducts and the corresponding actions that will be meted out to certain unbecoming actions. There can also be rules on how misconducts are reported for actions and so on.
- *Dispute Resolution:* Disputes in team should be managed to bring out the best of the teams. Depending on the nature of the assignment problems, course handlers and coordinator should provide robust leadership that would guide team through critical times.

Teamwork Assessment Process

There are many models on group-work assessment in literature; different studies have reported on how some of these models have performed in different disciplines and applications. In particular, [20] have reported on the application of a group-work assessment model called SPARK which was developed by [21]. This model can be applied for teamwork assessments.

In the model, students can be assessed both in summative and formative ways. The overall mark a student gets is based on the student's assessment of his work, how he was assessed by his team members and the overall mark of the group. Equation 1 below illustrates this group-work assessment model:

$$IM = TM \times ISPAF \quad \text{…. Equation 1}$$

Where IM = Individual's mark,
TM = Team Mark,
ISPAF = Individual's Self and Peer Assessment Factor

ISPAF is derived from the square root of total rating for each team member divided by average of total ratings for all team members.

For example, if the submission of a team is assessed as 80%, the SPA factor for each student will then be used to generate individual student's mark. Assuming there are 5 students in the group and each student is allowed to award up to 5 marks for him/herself and repeat the same for others based on their commitment to the team, the peer assessment factor (PAF) then become the total of all marked awarded to each student by their colleagues. See table 1 below:

Table 1: Peer Assessment Ratings

	Student 1	Student 2	Student 3	Student 4	Student 5
Student 1	***4.5***	3	3.5	3	1.5
Student 2	2.5	***5***	4	3	2
Student 3	3	3	***4.5***	3	3
Student 4	4	3	3.5	***5***	2.5
Student 5	3.5	3	4	3	***4***
Total PA	**13**	**12**	**15**	**12**	**9**

Based on table 1, individual students' mark is computed as Table 2 below:

Table 2: Finalizing individual's marks

	Individual Total	Average of Individual rating	Team mark	SPA	Individual mark
Student 1	13	12.2	80	1.04	83.26
Student 2	12	12.2	80	0.99	79.34
Student 3	15	12.2	80	1.11	88.8
Student 4	12	12.2	80	0.99	79.34
Student 5	9	12.2	80	0.86	68.8

Individual's self-assessment can be compared to how team members have assessed each student. SAPA, Self-Assessment to Peer Assessment, is calculated as the square root of individual's self-rating divided by the average marks awarded the student by his/her peers. For examples, using Table 1 above, SAPA factor for each of the members of this team are 1.11, 1.29, 1.10, 1.29 and 1.33 respectively.

When SAPA value for a student is greater than 1, each student has rating himself more than the rating of the team. As this is common to all the students in this team in the example above, the course handle has to review the work of such team and evaluate the contributions of each member. Asides, if dishonesty is suspected, SAPA factor can be used to divide the individual marks that was collated based on SPA.

CONCLUSION

PBL offers a unique constructivist approach to pedagogies. However, evidence from past studies suggests that students are engaged and assessed based on group-work rather than in teamwork scenarios that are common in practice. This study has elicited a debate on the relevance of team in preparing students for the *real world*, and has described a methodology on how teams are formed and assessed. A group-work assessment model by [21] was considered useful for assessing teamwork. While SPA awards students commitment to teamwork, SAPA can be used both as a confirmatory tool and deterrent when students are dishonest about their perception on how they have contributed to the success of their teams.

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