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The Influence of Three Teaching Methods on Undergraduate Physics Students' Group Work Skills

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Abstract
The purpose of this study is to compare the influence of three teaching methods, as represented by problem-based learning (PBL), the PBL with lecture method, and the conventional teaching on undergraduate physics students' group work skills among bachelor’s degree physics students. In this study, the pre- and post-test were done and the instruments were administered to the students for data collection. The actual sample size comprises of 122 students, who were selected randomly from the physics department, college of education in iraq. Overall, the statistical results rejected null hypothesis of this study. Thus, using the PBL without or with lecture method enhances the skills of the group work among the bachelor’s degree physics students, better than using the conventional teaching.
Keywords: Group Work Skills, Problem-Based Learning, PBL with Lecture Method, Conventional Teaching

Introduction

Problem-based learning (PBL) stems from the constructivist theory which postulates that students acquire knowledge through activities and learning experiences. Knowledge is socially produced through these interactions and collaborations in meaningful activities (Ishii, 2003; Koch, 2005; Saxe et al., 2009). Through interacting with their environment and investigations, conversations and tasks, individuals learn. New knowledge is then developed by contributing on current knowledge (Hernandez-Ramos & Paz, 2010). PBL is utilized to create a situation involving

a complex issue that students are requested to solve. Through the use of relevant, complex issues, students are urged to learn and develop disciplinary as well as problem solving skills. PBL is centered on student-focused learning and its utilization of ill-developed problems related to a specific subject matter enhances the student's higher thinking and interactions. Students are also encouraged to make use of the newly developed knowledge to solve problems (Sungur & Tekkaya, 2006).
According to several researchers (Prince, 2004; Sahin, 2009a; van Berkel & Schmidt, 2005), PBL can impact the learning process and generate positive outcomes. PBL is often described as an educational environment wherein learning is organized through a problem presented in a way that enables students to realize the acquisition of new knowledge for its solution (Montero & Gonzalez, 2009). It is an educational approach that facilitates and initiatives the learning process through complex, relevant and actual problems (Arzuman, 2010; Gijbels et al., 2005; Sahin, 2010a).

PBL implements positive outcomes in various fields and it contributes to the students' motivation indicating that PBL is a strong contender to be selected as an alternative teaching method for the subject of physics (Raine & Collete, 2003; Sahin, 2009b; Sahin, & Yorek, 2009). PBL as one of interactive engagement processes are widely acknowledged and used on a global scale and their common application in science and physics education is noted (Sahin, 2010a). In a related study Torp & Sage (2002) provided a description of PBL as a focused, experiential learning involving the investigation and formulation of solutions for a real-world, complex problems in which have no only one correct answer or those which have many appropriate ones. Moreover, PBL encourages learning for long life and basically teaches students how to learn. The PBL effectiveness in science subjects have been addressed by various studies with various findings (Akinoglu & Tandogan, 2007). However, these studies are of the consensus that PBL results in positive student attitudes (Prince, 2004).

In addition, PBL was created not to focus on problem solving, but on developing and using the required cognitive skills for problem solving (Massaro, Harrison & Soares, 2006). In PBL classes, students handle important problems within an actual context (Suh, 2005). For the solution to such problems, students are urged by instructors to examine the possibilities, develop alternative solutions, cooperate with one another, test concepts and hypotheses, employ new thinking ways, and bring forward the best solutions. Thus, PBL ensures that any knowledge and skill acquired in school may be used in actual situations (Hoffman & Ritchie, 1997). Group work skills for PBL have been used in this study as a measurement to show the level to which the student possesses the necessary abilities to participate in PBL.

PBL appears to improve interpersonal as well as group work skills in team, makes learners novice scientists, and increases learners' attention in science (Araz & Sungur, 2007; Galand et al., 2003; Sungur & Tekkaya, 2006).

In PBL, students work together in a group to attain objectives; as collaboration, interaction, communication, and discussion. PBL allows the development of students' group work skills.

Therefore, students collaborate to work cooperatively with others in a team and assume responsibility for their own learning. PBL also allows students to search information from any subject (Ball & Pelco, 2006; Cheong, 2008). This process also allows the team to learn to work together to determine the logistics of the problem at hand and utilize higher order thinking skills (Holter, 1994), incoming broad assortment of resource and learners' experiences and develop respect for various opinions (Williams, 2001). In the current study, the PBL without or with lecture method compared with conventional teaching method were used to investigate their effectiveness on the group work skills among bachelor's degree physics students.

Problem Statement

One of the most successful approaches is problem-based learning (PBL) (Prince, 2004; Sahin, 2009a; van Berkel & Schmidt, 2005). PBL achieves the constructivism idea by building on previous knowledge skills and constructing on present cognitive frameworks which is advantageous in future professional life (Xiuping, 2002). It is more efficient than traditional science teaching method. Moreover, there are several reasons for using PBL in the current study, one of these is weakness of the traditional science teaching method, under which the traditional teacher-centred learning assumes that all learners take in recent material in a like speed and have like degree of knowledge in the topic being taught. A teacher guides the students and offers them new information. The focus of teaching is on the transmission of knowledge from the expert teacher to the novice learner (Cheong, 2008).The role of students, in the conventional manner, is passive rather than an active, thus hindering learning among bachelor's degree physics students.

Under the conventional manner, students listen and watch, and most teaching time is spent with the instructor lecturing. To enable understanding of the physics content, students are required to individually work on tasks, and collaboration is encouraged. In the traditional method, a teacher is required to have or to learn effective writing and speaking skills. Mostly, under traditional experiments of science, students have conceptions on what the findings will be, or what they anticipate it to be, and the student tries to emphasize on this (Azu & Osinubi, 2011; Cheong, 2008).

Therefore, there is a need to adopt PBL for solving the problem of the traditional science teaching method. In recent years, educational institutions have evidenced the requirement of utilizing substitutional teaching methods to develop learners' abilities (Azu & Osinubi, 2011). PBL, as a teaching method, was primarily developed to address the attendant difficulties in conventional methods and respond to the conventional methods which failed to enable students to solve problems of to solve problems of various topics in physics material (Hung, Jonassen, & Liu, 2008).

To enhance a deeper understanding of the content, the interaction between the problem and use of knowledge must be done. PBL environment establishes the relationship between the knowledge and its use (Ball & Pelco, 2006). Instructors in PBL are more creative with their teaching while old methods, which are based on boring lectures and memorization of material, are challenged with this delivery method (Ates & Eryilmaz, 2011; Sulaiman, 2011). According to

McParland, Noble and Livingston (2004), the PBL curriculum is significantly more successful than the previous, traditional course (p. 859). Tang (2008) pointed out that PBL is accepted by most students and teachers as a teaching method, and is believed to improve understanding ability. In PBL, student-centred learning method shifts the concentration of effectiveness from the instructor to the students to reduce teacher-centred learning. Unlike the traditional teaching method, PBL enables student-centred teaching approaches, resulting in active participation of students in solving problems, answering questions, engaging in cooperative learning, working in groups on problems, and taking on more responsibility for learning (Ates & Eryilmaz, 2011; Ball & Pelco, 2006; Cheong, 2008; Subramaniam, Scally, & Gibson, 2004).

Based on previous literature, the PBL allows the development of the group work skills to make students cooperatively work in a team. The PBL allows learners to pursue information from any subject, and this allows them to deeply understand science concepts (Ates & Eryilmaz, 2011; Ball & Pelco, 2006; Cheong, 2008; Subramaniam et al., 2004). Ates and Eryilmaz (2011) asserted that student-centred learning allows depth of understanding of material, acquisition of new materials and creative skills such as problem-solving, group work, among students. Evidently, it is superior to the traditional teacher-centred instruction. The skills of group work are important to shift the responsibility of learning from the instructor to the student. The shift occurs in an environment of cooperative learning of group work (Halpern, 2000).

Students have opportunities to evaluate their understanding of study materials with others team members through social interaction. It encourages greater understanding, thereby revealing difficulties of understanding the physics concepts in light of teaching and learning, curriculum, science instruction, and content-level understanding by learners (Sellitto, 2011; Whitcombe, 2013). Education research indicates that, using group work skills is one of the most effective and invaluable teaching tools that can help students to increase learning and retention of what is taught for a long time, acquiring many different ideas on a subject and academic background, and finally, preparing them for project work in a professional environment as PBL (Abdelkhalek et al., 2010).

According to Seymour (2013), PBL, as an appropriate teaching mode, has a favourable influence on the progress of the team-working skills of students. These skills are important to master and enable effective collaborative working. Some studies revealed that students learning under a PBL method possess improved ability to enhance work in teams (Antephol et al., 2003; Grady et al., 2009; Reeves et al., 2004). These studies suggest positive outcomes in terms of team working skills. The terms 'teams' and 'groups' are overwhelmingly used interchangeably within the literature but PBL literature prefers the term 'group' (Baptiste, 2003).

Actually, PBL caters requirements to a broad assortment of resource and learners' experiences and on developing respect for various ideas through cooperative group work (Williams, 2001). Findings of prior studies support that PBL offers students the opportunities to develop skills of group work for solving problems (Bell, 2012; Downing et al., 2011; Whitcombe,2013). Extensive researches have been conducted on the benefits accrued through cooperative learning experience like group work (Kreie et al., 2007).

It is worth mentioning that using the PBL approach alone and adopting it only as a teaching method, is considered risky because it entails complete shift from a teacher-centred learning in conventional manner to another student-centred learning in the PBL. PBL, as an instruction process, centers on the precept of using problem, which should be complex and ill-structured, that will lead to drastic change in learning approach. Under the PBL method, students are encouraged to be active rather than passive and cooperate rather than compete (Cheong, 2008). Incorporating PBL into traditional method could be a useful tool to reinforce material covered in traditional lecture, and can be a positive influence on the learning process (Liceaga, Ballard & Skura, 2011). According to Saalu et al (2010), “there should be an intelligent combination of using both the traditional and PBL approaches for teaching anatomy which may provide the most effective training for undergraduate medical student” (p. 197).

Objective of The Study

To compare the effects of using problem-based learning (PBL), the PBL with lecture method, and the conventional teaching on group work skills among bachelor’s degree physics students.

Research Question

Are there significant differences on the linear combination of posttest mean scores of group work skills among bachelor’s degree physics students who followed PBL, the PBL with lecture method, and the conventional teaching after the effect of pretest mean scores is controlled?

Research Hypothesis

There are no significant differences on the linear combination of posttest mean scores of group work skills among bachelor’s degree physics students who followed PBL, the PBL with lecture method, and the conventional teaching after the effect of pretest mean scores is controlled.

Methodology

Research Design

This study followed a nonequivalent control group design to compare the effects of three methods as represented by problem-based learning (PBL), PBL with lecture method, and conventional teaching method on the group work skills among bachelor’s degree physics students.

This study’s design can be represented schematically as O_1 the pretest on the group work skills; O_2 the posttest on the group work skills; X_a represents PBL treatment; X_b represents PBL with lecture method treatment; X_c represents the conventional teaching method, as shown in Table 1.

Table 1
Nonequivalent Control Group Design

No	Group	Pretest	Treatment	Posttest
1	Experimental	O_1	X_a	O_2
2	Experimental	O_1	X_b	O_2
3	Control	O_1	X_c	O_2

The sample consisted of three groups of the bachelor's degree physics students. The first experimental group used PBL treatment, and the second experimental group used the PBL with lecture method treatment, while the third group was a control group and it used conventional teaching. The number of items in group work skills questionnaire consists of 15 items. Aforementioned instruments were administered to whole groups before and after the treatments.

Distribution of Groups
There were three groups, which consist of 122 students involved in the study, the distribution of three groups was based on the teaching methods that followed the PBL method(42 students), the PBL with lecture method(39 students), and the conventional teaching method(41 students).

Population and Sample
The population for this study comprised of bachelor's degree physics students male and female (176) students enrolled in the Physics Department, College of Education in Baghdad Iraq, for academic year 2011-2012. The sample size was 127 selected from students of the bachelor's degree physics in the Physics Department, College of Education in Baghdad Iraq, in the second session of academic year 2011-2012. Finally, five students of the sample dropped this study, so the actual sample size was 122 students.

Instrument of the Study
Questionnaire on group work skills was adapted based on the team work skills questionnaire of Lambros (2004) to collect data for the present study. Aforementioned questionnaire consists of 15 items, measuring student's skills of group work. The group work skills questionnaires were administered to the bachelor's degree physics students, before and after the treatment to measure the effectiveness of PBL alone or with lecture method, compared with conventional teaching method on the group work skills.

Findings
The results revealed that univariate test of statistical significance on the differences observed in the scores of posttest across the various groups, as shown in table 2.

Table 2: *Univariate Analysis of Subjects' Posttest Scores on Group Work Skills in Various Groups*

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	Posttest	8948.54	5	1789.71	79.14	.00
Intercept	Posttest	301.51	1	301.51	13.33	.00
Pretest	Posttest	5188.01	1	5188.01	229.42	.00
Group	Posttest	3012.17	2	1506.08	66.60	.00
Error	Posttest	2623.24	116	22.61		
Total	Posttest	398319.0	122			
Corrected Total	Posttest	11571.78	121			

The scores of posttest questionnaire on group work skills across the various groups with *f* (2, 116) = 66.60, mean square = 1506.08 and *p* = .00. Therefore, these differences in the scores of posttest questionnaire on group work skills among the three groups were significant. So, the statistical results rejected the null hypothesis. Thus, there were significant differences on the linear combination of posttest mean scores of group work skills among bachelor's degree physics students who followed pbl, the pbl with lecture method, and the conventional teaching.

Overall, the results of comparison among the groups which were the PBL, the PBL with lecture method, and the conventional teaching, indicated that there were statistical significant differences. Thus, the results of univariate statistics were further investigated by performing a post hoc pairwise multiple comparison using LSD command for the group work skills in order to identify significantly where the differences in the means resided.

Table 3 depicts a summary of post hoc pairwise multiple comparisons across the groups of the PBL method, the PBL with lecture method, and the conventional teaching method, to study superior effects on the students' group work skills.

Table 3 *Summary of Post Hoc Pairwise Multiple Comparisons Observed Means Scores of Posttest of Group Work Skills*

Dependent Variable	(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.
Posttest of group work	(1) PBL	PBL with lecture	3.80*	1.81	.04
		conventional	13.05*	1.78	.00
	(2) PBL with lecture	PBL	-3.80*	1.81	.04
		conventional	9.25*	1.82	.00
	(3) conventional	PBL	-13.05*	1.78	.00
		PBL with lecture	-9.25*	1.82	.00

* The mean difference is significant at the .02 level.

Statistical results showed there were significant differences, with $P < .02$ on mean scores of posttest of the group work skills between the PBL method of first group and the conventional teaching method of third group, with Mean Difference = 13.05*, in favor of the PBL method which was superior and better than methods of other groups. As well, there were statistically significant differences, with $P < .02$ on mean scores of posttest of group work skills between the PBL with lecture method of second group and the conventional teaching method of third group, with Mean Difference = 9.25*, in favor of the PBL with lecture method which was better than the conventional teaching method.

In addition, there were no statistically significant differences, with $P > .02$ on mean scores of posttest of the group work skills between the PBL method of first group and the PBL with lecture method of second group. Thereby, the PBL method was superior and better than the conventional teaching method, and moreover, PBL with lecture method was better than the conventional teaching method. In sum, the PBL without / with lecture method was better than the conventional teaching method. Therefore, using the PBL method or the PBL with lecture method enhances the group work skills among bachelor's degree physics students better than the conventional teaching method.

Discussion

The mean scores on posttest of group work skills questionnaire among students who followed problem-based learning (PBL) method were significantly higher than their peers who followed the conventional teaching method, after the students faced five problems on thermodynamics. Overall, the experimental treatment of PBL without or with lecture method was able to enhance greater and better group work skills than the conventional teaching method among students. In other words, PBL students demonstrated a greater ability to get higher scores of response on posttest questionnaire items of the group work skills than their peers in the conventional teaching method group. The posttest questionnaires were administered under supervision immediately after the subjects completed their materials on thermodynamics.

Thus, the finding of this study found that the PBL without or with lecture method enhances skills of the group work among bachelor's degree physics students. Several studies supported this finding and showed that PBL allows the development of the group work skills (Ates & Eryilmaz, 2011; Ball & Pelco, 2006; Cheong, 2008). The skills of group work are important to shift the responsibility of learning from the instructor to the student. The shift occurs in an environment of cooperative learning of group work (Cooper, Sloan, & Williams 1988; Halpern, 2000). This may be an application to team exercises or a case study, but it also allows the team to learn work together to determine logistics of the problem at hand and utilize higher-order thinking skills (Holter, 1994).

This finding also replicated the results obtained by Hmelo-Silver (2004) who earlier demonstrated the superiority of the PBL method over the conventional teaching in bringing about students' work in collaborative groups to know what they require for solving problems. According to Ates and Eryilmaz (2011), PBL is a student-centred teaching approach that enables students to become active participants in solving problems, answering questions, cooperating in learning, working in teams on problems or projects, and taking on more of the responsibility for learning. Moreover, group work skills in PBL was used in this study as a measurement to show the range of student's possession of the skills needed to participate in group work. PBL appears to improve teamwork, increase students' interest in the course, and make students apprentice scientists (Araz & Sungur, 2007; Galand et al., 2003; Sungur & Tekkaya, 2006). In point of fact, those students who followed PBL do their activities in a group to attain purposes; such as collaborating, interacting, communicating, and talking. PBL allows the development of students' group work skills, therefore students collaborate to work cooperatively with others in a team and assume responsibility for their own learning (Ball & Pelco, 2006; Cheong, 2008).

There are many reasons for this result; where, in PBL the student-centred learning method shifts the concentration of action from the instructors to the students to reduce teacher-centred learning. Unlike the traditional teaching method, PBL enables student-centred teaching approaches, resulting in active participation of students in solving problems, answering questions, working in groups, engaging in cooperative learning, and taking on more responsibility for learning (Ates & Eryilmaz, 2011; Ball & Pelco, 2006; Cheong, 2008; Subramaniam et al., 2004). PBL students tend to do better research and work better in group, based on opinion of students, who reported the aforementioned (Sungur et al., 2006). Furthermore, in PBL, participants are submerged in activities continuously that construct upon experiences and prior knowledge. It helps students to thoroughly probe a problem by answering questions, making observations and collecting data, and examining hypotheses. Also, PBL gives the chance for quick application of recently obtained information and requires that the participants labor as a team (Massaro et al., 2006). This study showed improvement of the group work skills by using PBL, can help students to take responsibility for their own learning (Brookfield, 2009; Deepwell & Malik, 2008; Sungur et al., 2006). Sundry studies showed that PBL allows the development of group work skills, thus making students cooperatively work in a team (Ates & Eryilmaz, 2011; Ball & Pelco, 2006; Cheong, 2008). PBL students tend to do better research and work better in group, based on opinion of students, who report the aforementioned (Sungur et al., 2006). Furthermore, in PBL participants are submerged in activities continuously that construct upon experiences and prior knowledge.

It helps students to thoroughly probe a problem by answering questions, making observations and collecting data, and examining hypotheses. Also, PBL gives the chance for quick application of recently obtained information and requires that the participants labor as a team (Massaro et al., 2006). Cooperative learning is part of creating the social constructivist theory, so a social constructivist lecture hall requires students to develop skills of group work and to view individual learning as significantly linked to the group's learning success. Students are not only discouraged to work with teachers but encouraged also to work with other students as a group. Students have many things to offer one another, and at the same time they hold the responsibility of researching the theme and presenting their findings. After the completion of activities in a group, the knowledge happens in each individual at various rates based on the student's experience. Hence, this study showed improvement of the group work skills, which help students take responsibility for their own learning (Brookfield, 2009; Deepwell & Malik, 2008; Sungur et al., 2006).

Conclusion

This study provides evidence to support the development of group work skills which is necessary in the implementation of problem-based learning (PBL), so using the PBL without or with lecture method enhance and develop the group work skills, among physics undergraduates, better than using the conventional teaching method. Consequently, PBL without or with lecture method reduce teacher-centred learning of traditional method and enhance student-centred learning, as much as possible.

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