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The Effect of Student-Centered Teaching and Problem-Based Learning on Academic Achievement in Science

Gezim BARA[1], Nazmi XHOMARA[2]

[1] Dr., Department of Biology, Faculty of Natural Sciences, University of Tirana.
[2] Dr., Department of Mathematics and Statistics, Faculty of Information and Innovation Technology, Luarasi University, Tirana, Albania, ORCID ID: https://orcid.org/0000-0003-1810-525X.

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ABSTRACT

The study aimed to investigate the relationships between student-centered teaching approach, problem-based learning, and academic achievement in science teaching. The quantitative quasi-experimental research approach was adopted in this study. The data of the study was collected by a structured questionnaire. The sample of the study consisted an experimental group students (N= 215) and a control group students (N=204) by cluster random sampling. The results showed a significant difference in the student-centered teaching approach, problem- based learning, and academic achievement scores for experimental and control group of students. It is found that there is a low positive correlation between student-centered teaching approach and academic achievement, although there are significant differences between the experimental and control group. The study revealed that there is a medium positive correlation between problem- based learning and academic achievement, although there are significant differences between the experimental and control group. At the same time, it is revealed that the total variance of academic achievement levels explained by the student-centered teaching approach and problem- based learning is relatively a high percentage.

Keywords: Student-centered teaching, problem-based learning, academic achievement, science teaching.

INTRODUCTION

The teaching and learning approach seemed to be important for academic achievement in science education. Ozfidan et al. (2017) showed that science teachers' beliefs about reformed learning and teaching are statistically high, and science education aim is based on constructivist views on learning and teaching. Belin and Kisida (2015) revealed that attitudes of toward evolutionary science are strongly related to science achievement. In addition, Taylor et al. (2018) uncovered that the use of a structured argument-based inquiry approach in science instruction has shown initial success in improving science achievement. Johnson, Bolshakova and Waldron (2016) indicated that transformative professional development enabled significant growth in teacher quality and student science achievement. Sukardiyono,

Correspondence author e-mail: nazmixhomara@hotmail.com © ISSN:1304-6020

Rosana & Dwandaru (2019) found out that integrated science instruction impacts the students' science process skills, such as predicting, experimenting, observing, and measuring. Idin and Dönmez (2017) unearthed that many science teachers believed that the gender equity issues are important for students' science achievement.

The purpose of the study is to investigate the relationships between student-centered teaching approach, problem-based learning, and academic achievements, as well as the influence of student-centered teaching approach, and problem- based learning on academic achievement in science teaching. The research questions include: (1) Is there a significant difference in the mean of student-centered teaching approach, problem- based learning, and academic achievement scores for the experimental and control group of students? (2) Is there a positive linear correlation between the student-centered teaching approach and academic achievement? Does academic achievement increases with the student-centered teaching approach? (3) Is there a positive linear correlation between problem-based learning and academic achievement? Does academic achievement increases with the problem-based learning? (4) How much of the variance in academic achievement scores can be explained by the student-centered teaching approach and problem-based learning?

Literature Review and Theoretical Framework

According to Howe and Berv (2000), constructivism includes active form of thoughts and ideas. In other words, the constructivist approach requires active participation in the classroom to develop the learning process. Constructivism treats individual as actively involved in thinking and learning (Howe and Berv, 2000). In constructivism, learners participate in generating understanding (Brooks & Brooks 1993). Constructivism theory was used to conceptualize a research framework for this study.

Conceptual framework

The framework for the study was developed from an extensive review of existing evidence about lecture and discussion methods, and knowledge building by students. The review began with a search for relevant empirical research through ERIC, Sage, and EBSCO using the keywords "science student-centered teaching approach", "problem-based learning", and "academic achievement". Figure 1, summarizing the framework resulting from our review, proposes a set of relationships among three constructs; student-centered science teaching approach and problem-based learning as independent variables influence academic achievement dependent variable.

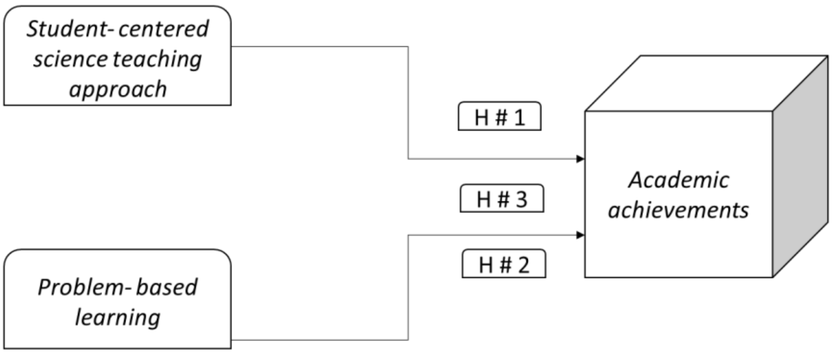

Figure 1. Conceptual framework

The student-centered teaching approach and academic achievement

The student-centered science teaching approach is considered to be in a linear positive relationship to the academic achievement of students in science teaching. Ahmad et al. (2011) revealed that the basic considerations of the teachers in both science and arts groups during selecting the instructional methodology for the students included subject matter, number of students in the class, the environment of the classroom, school policy, assessment criteria and grade level of the students. Student performance on the natural world is positively correlated to teaching methodology (Hurney et al., 2011) as well as conducted experiments and laboratory course as a new teaching method increase the interest of students and permit students to develop their group-work and communicate skills, and peer evaluations both improve students' communication skills and promote metacognitive refection (Ashton, 2008; Bagán, Sayós, and García, 2015). Dopico and Garcia-Vazquez (2011) revealed that when students are engaged through research with traditional cultural practices of environmental management, they better understand how positive pedagogy can be used to stimulate the interactions between humans and the environment. Zusevics et al. (2013) found that various components of the project-based learning approach used in the project health high school curriculum were viewed as positive by health educators, students, and teaching assistants. Jalali et al. (2012) uncovered that the innovative methodology allows students to have a hands-on experience of lithography without using expensive equipment typically found only in a cleanroom. Ruiz-Martinez (2013) confirmed that the hands-on experience enables an enhanced learning process of the different concepts and their practical skills of students. Tripken, (2016) reported that the students positively evaluated the online software decision-making program, values exchange and noted an improved learning experience as a result of using the tool. In the same vein, it was underlined that an online educational technology course contributed to the teacher candidates' development of technological pedagogical content knowledge and improved their attitudes and beliefs on their technology integration practices (Wilder and Lim, 2011). Thompson (2015) found a positive correlation among the predictor variables of fifth-grade science teachers' science teaching efficacy and science teaching outcome expectancy to the criterion variable of student achievement in science teaching. Duren and Cherrington (1992) found that prealgebra students who practiced in cooperative groups demonstrated greater long-term memory of problem-solving strategies compared to independent practice approach. Park, Park and Lee (2009) suggest that Earth science activities in Korean textbooks appropriately reflect comprehensive Earth science methodologies and provide students with more opportunities to develop their scientific literacy related in Earth, while the American curriculum included only a small number of inquiry-based activities. Yadav and Beckerman (2009) found that the case study approach was more beneficial in helping students develop applied problem-solving skills than the lecture for the applied plant science students. On the other hand, Martinez, Madrid, and Felice (2009) revealed that a simple approach facilitates the teaching of the concept of half-cell potential and the basics of sensors to make an iridium oxide electrodeposited pH sensor as well as students learn to build the electrode, to calibrate it, and to measure its sensitivity, repeatability, and time-response. Goldhaber and Theobald (2013) showed that more than 99 percent of teachers in several districts were rated "satisfactory "which does not comport with empirical evidence that teachers differ substantially from each other in terms of their effectiveness. Collet and Wyatt (2005) showed that students can progress through initial research and development phases or undertake an industry-based internship working as a team on initial concept projects. Alwahaibi et. al (2019) indicated that by employing effective instructional strategies and engaging curriculum, schoolteachers could facilitate students to develop positive intentions to continue learning science subjects in post-secondary education.

Mulyeni, Jamaris & Supriyati (2019) revealed that the basic science process skills improved through an inquiry-based approach such as the interactions with both peers and teacher.

Therefore, as the abovementioned authors indicated, there is a linear positive relationship between the student-centered science teaching approach and the academic achievement of students in science teaching. In a different point of view, Gao and Wang (2016) revealed that the inquiry-based instruction was not significantly associated with the content and problem-solving achievement; the mixed teaching approach had a significant positive relationship for student's content and problem-solving achievement, and the relationship between practice-based approach with content and problem-solving achievements were not significant. Therefore, it is hypothesized that:

Hypothesis # 1: There is a positive linear correlation between the student-centered teaching approach and academic achievement in science teaching.

The problem- based learning and academic achievements

The problem-based learning is considered to be in a linear positive relationship to the academic achievement of students in science teaching. Grabau and Ma (2017) found that all aspects of science engagement: science self-concept, enjoyment of science, instrumental motivation for science, the general value of science, and personal value of science were statistically significantly and positively related to science achievement, and nearly all showed medium or large effect sizes. In the same vein, Odom and Bell (2015) revealed that attitudes toward science and student-centered learning were positively associated with science achievement. Stecker, Fuchs, and Fuchs (2005) described that positive effects for curriculum-based measurement were associated with the use of class profiles and implementation of peer-assisted learning strategies. Post et al. (2006) revealed that by using a journal article as the framework, students were able to both understand the regression analysis method and also compare their results to the published map. Student attitudes towards courses, student self-efficacy, and interests in science subject are positively correlated with experimental modifications in the design and conduct of the course (Kitchen et al., 2007). A clinical anatomy project which incorporates explorative learning can be an effective way for the student introduction to the skills needed for patient write-ups and oral presentations (Philip et al., 2008). The contemporary problem-based learning methodology and cooperative learning support teaching and learning as well as increasing interest in science teaching (Harris, 2009; Coca, 2012). Student-staff partnership and peer-learning as well as model-based learning improved understanding of bioinformatics and its relevance to research, developed a better understanding of the subject, and influenced restructuring students' mental models in addition to the development of meaningful learning to teach the "seismic effects on soils and buildings" (Mello et al., 2017; Moutinho, Moura and Vasconcelos (2017). Casanoves (2017) showed that scientific reasoning and evidence-based decision-making to solve the given enigmas which is learner-centered approach to improve students' knowledge of genetics. Andersson and Reimers (2009) suggested that students' learning outcomes improved student perceptions of computer information systems instructors with information technology certifications positively enhanced their assessment of the instructor effectiveness, teaching methodology, and student engagement. Montgomery and Donaldson (2014) indicated that problem-based learning methodology in honors, paleontology-oriented, Earth Science course provide highly favorable responses by the students. Nelson (2012) found that students recognized the academic value of technology as it helped them to access a wide range of resources, and take control of their learning. Toledo and Dubas (2016) proposed the use of Marzano's taxonomy of learning, because it offers a functional way to distinguish lower to higher-order thinking, and is particularly useful to instructors interested in helping students develop higher-order thinking skills in science. Godor (2016) argued that student learning approaches research has been built upon the notions of deep and surface learning. Efendi-Hasibuan, Ngatijo & Sulistiyo (2019) revealed that inquiry-based chemistry learning has a very little influence on students' science achievement. Bahari & Aksut (2020) showed that activity-based science teaching practices were effective in improving preschool children's-solving skills. Therefore, as the abovementioned authors indicated, there is a linear positive relationship between the problem-based learning and academic achievement of students in science teaching. Therefore, it is hypothesized that:

Hypothesis # 2: There is a positive linear correlation between problem-based learning and academic achievement in science teaching.

The student-centered teaching approach, problem- based learning, and academic achievement

The student-centered science teaching approach and problem-based learning are considered to be in a linear positive relationship to the academic achievement of students in science teaching. Montrezor (2016) found that engaging in activities with active methodologies improved student performance compared with not performing the activities. Thoron and Myers (2011) revealed that students taught through inquiry-based instruction were reported as having higher content knowledge achievement than students taught through the subject matter approach in agricultural science education. An active learning system with a student-centered focus and e-learning activities (Fabregat-Sanjuan et al., 2017), students' use of mobile computing devices (Swan et al., 2005), and electronic discussion (Mackinnon, 2006) show a significant improvement on engagement, academic results, student motivation in learning activities and support learning processes as well as improvement in their ability to formulate arguments, to lead effective discussions, and to substantiate their conceptual frameworks. Rana and Dwivedi (2017) indicated that the use of clickers in the classroom setting explains variance of 43.2 percent in learning performance of information and communication technology students. From the other point of view, Zuniga (2015) revealed that students who self-enrolled in the flipped classrooms had statistically significantly better student achievement level than those students who self-enrolled in the online courses. Poggi, Miceli, and Testa (2017) found that the research-based interdisciplinary teaching predict a better understanding of the energy concept, supporting the effectiveness of an interdisciplinary approach in the teaching of energy in physics and science teaching in general. Hedley (2013) revealed that the use of geospatial technologies (GST) within a student/teacher/scientist partnership improved the geospatial skills and atmospheric science concept knowledge. Briese and Jakubowsk (2007) found that a laboratory project biochemistry course which integrates the traditional classroom study of the structure and function of biomolecules with the laboratory study improved understanding of the students on fluorescence spectroscopy. Differentiated teaching (Alexander, 2013), and experiential learning (Mohan, 2015) had statistically significant greater mean scores in academic performance and in critical thinking questions on the living environment, earth science and chemistry. Aguilar-Valdez (2013) revealed that high-achieving students flourishing informal school science and informal science settings. Margulies and Ghent (2005) revealed that changing the assessment strategy from the traditional scheme of two or three exams and one final to a new model of seven or eight shorter exams have a positive impact on student comprehension and attitude in a microbiology course. Teaching and learning methods influence the substantial positive effects of science with a focus on model or applications and interactive science teaching and learning on science achievement and interest in science teaching (Purser and Renner, 1983; Areepattamannil, 2012). From the different points of view, Gao (2014) found that for the low performing students, none of the measured inquiry-based teaching practice items had a significant relationship with the science achievements at any performance levels of students. However, for medium- and high-performing students, none of these inquiry-based or traditional didactic science-teaching practices were found to be positive predictors of science performance. It is indicated that science students taught with dioramas (Aslan, 2017), concept mapping (Ogonnaya et al., 2016), Jigsaw method based on cooperative learning (Karacop, 2017), and drama-based science teaching (Abed, 2016) were better in science learning skills than those taught with traditional learning method. Ohle, Boone, and Fischer (2015) revealed that the sequencing of learning processes within a lesson was found to be a positive predictor for student achievement. Therefore, as the abovementioned authors indicated, there is a linear positive relationship between the student-centered science teaching approach, problem-based learning and academic achievements of students in science teaching. From the different points of view, Gurganious (2017) revealed no significant relationships between eighth-grade science teachers' perceptions of their autonomy, teaching practices, their science curriculum, and eighth-grade science achievement scores.

The student-centered science teaching approach and problem-based learning are considered to be the most important variables that influence the academic achievement of students in science teaching. Raved and Assaraf (2011) found that the most significant influential factors underlying the attitudes towards science studies were: interpersonal interaction between teacher and student, the relevance and authenticity of the topics being studied, and the diversity of the teaching methods. Rodríguez et al. (2013) found that the leadership style associated with the profile of the student, role play of group coordinator and the member profile combinations influence the group success. Tatar et al. (2016) found that the most important factors affecting student science achievement according to student science teachers are the items in the dimensions of teacher and curriculum, and the most important predictor of science achievement is "teaching the topics in a way that may arouse the student curiosity". Thomas and Strunk (2017) showed teacher expectancy for children success in science teaching did not significantly predict fifth-grade students science achievement, but parent expectancy did. The basic and interactive classroom (Paz-Albo, J., 2017), research one-to-one faculty-to-student (Nadelson, Walters and Waterman, 2010), and cooperative learning (Fernandez-Santander, 2008) enable students to work according to their unique learning rhythm, helping them develop strategies to overcome challenges along their learning journey and achieve their goals as well as increased interest in knowledge of science, and increase the mean score of the student academic results. Ediger (2018) advocated the importance of vital topics in science teaching and learning in the curriculum as well as knowledge and skills in in-service education of science teachers to optimize learner achievement and progress. Dagher et al. (2004) showed that astronomy course students expressed slight levels of variation between their reasoning about scientific theories in general and specific theories they learned in the course. González et al. (2016) found that a pedagogical approach using narrative and documentary film in a freshman science course is an effective means for promoting an understanding of the endeavors and contributions in science and developing an increased awareness of issues concerning diversity and ethics. Whitman and Wendy (2016) revealed that the student grades were higher both in the traditional and flipped classes as compared to the online section. Rivard and Gueye (2016) suggested that the language-enhanced teacher practices had a positive impact on the use of talking, reading and writing by students in the science classroom. Unger et al. (2016) found that students receiving hands-on instruction in estimating area using the transect method can record accurate area measurements after only a limited 2-hour introduction. Jacobs et al. (2016) indicated that adopting a wealth of evidence-based teaching practices for teaching programming skills naturally gives rise to greater learning efficiency. Mehta, Mehta, and Seals (2017) argued that aesthetic and humanistic motivations such as wonder, curiosity, and social justice are inherent reasons for doing science. Añino et al. (2014) revealed that performing computer assignments has allowed students and teachers to identify errors and misconceptions that might have gone unnoticed under a more passive approach. Msoka, et al. (2015) showed that students found the interactive experiments as usable as an alternative to physical experiments. In parallel, Holveck (2012) found that students in traditional approach made the greatest learning gains at the qualitative level of density explanation while more students in the inquiry approach had a quantitative understanding of density at the end of the study with respect to students in the traditional group. Frank et al. (2017) concluded that the social breaching approach is effective in letting students with a natural science background explore and experience the power of social reality. Lewis (2014) indicated that no evidence was found for the reform impacting student academic performance in subsequent classes. Crossman (2016) revealed that the teaching principles and practices of behavior change through a behavior change plan approach improve liberal learning outcomes and personal health. Aguilar-Valdez (2013) argued that through critical race methodology Latino students' struggles and successes reveal their crossing of cultural and political borderlands and negotiating structures of schooling and science. Schoen, Weishet and Kennedy (2007) showed that science teachers are enthusiastic about possibilities of the program Science Across the World offers and suggest the in-service training. Therefore, as the abovementioned authors indicated, the student-centered science teaching approach and problem-based learning are the most important variables that influence the academic achievement of students in science teaching.

Therefore, it is hypothesized that:

Hypothesis # 3: Student-centered teaching and problem-based learning predict academic achievements in science teaching. The variance in academic achievement can be explained by scores on these two scales.

METHODS

a) Method

The quantitative quasi-experimental approach is the method used in the study. Quasi-experimental designs do not include the use of random assignment. Researchers who employ these designs rely instead on other techniques to control or at least reduce threats to internal validity (Fraenkel, Wallen, & Hyun, 2017). The experimental group of students is compounded by students of A university where lectures were trained to use student-centered teaching. The control group of students is compounded by students of B university where lecturers use traditional teaching. The two groups of students were from the same study program (science students) and the same year of study (second year). So, the teaching approach was the manipulated variable in the study, whereas the researchers control problem-based learning as well as other variables that may influence the relationships in the study. The student-centered teaching approach and problem-based learning are considered discrete variables, meanwhile academic achievement is considered a quantitative continuous variable.

b) Design

The matching-only design as an important option of the quasi-experimental research design was used in the study. The matching-only design differs from random assignment with matching only in the fact that random assignment is not used. Meanwhile, the researcher still matches the subjects in the experimental and control groups on certain variables, but he has no assurance that they are equivalent to others. At the time when several groups are available for a method study and the groups can be randomly assigned to different treatments, this design offers an alternative to random assignment of subjects. After these groups have been randomly assigned to the different treatments, the individuals receiving one treatment are matched with individuals receiving the others (Fraenkel, Wallen, & Hyun, 2017).

c) Instruments

The structured questionnaire was used to collect the primary quantitative data of independent and dependent variables from students. The structured questionnaire is based on the relevance of the science education (Rose) questionnaire (Camilla and Svein, 2004), and is adapted, piloted and applied by the researchers. Cronbach Alpha values of questionnaire scales vary from 0.085 to 0.092 confirming a very good value of reliability.

d) Participants

In the study, experimental group of students (N= 215), and a control group (N=204) were selected in terms of cluster random sampling. There are 150 females (69.8.1 percent) and 64 males (29.8 percent) in the experimental group and 122 females (59.8 percent) and 81 males (39.7 percent) in the control group.

e) Procedure

Central tendency values as well as frequency values were used to describe student-centered teaching approach, problem- based learning, and academic achievement for both, experimental and control groups. The relationship between student-centered science teaching approach, problem-based learning and academic achievement were investigated using the Pearson correlation coefficient. Linear multiple regression was used to assess the skills of two control measures to predict academic achievement levels by student-centered teaching approach and problem-based learning. Preliminary assumption testing was conducted to check for normality, linearity, univariate and multivariate outliers, homogeneity of variance-covariance matrices, and multicollinearity, with no violations noted.

FINDINGS

Descriptive statistics
Student-centered science teaching approach

Table 1: Student-centered science teaching approach frequencies

Science student- centered teaching approach

		Experimental group		**Control group**	
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1.00 Never			103	50.5
	2.00 Ocassionally			68	33.3
	3.00 Neutral	19	8.8	18	8.8
	4.00 Often	79	36.7	14	6.9
	5.00 Very often	116	54.0		
	Total	214	99.5	203	99.5
Missing	System	1	.5	1	.5
Total		215	100.0	204	100.0

About the experimental group, as shown in table 1, 293 respondents (90.7% of the sample) claim that the student-centered teaching approach is used often or very often, and

19 respondents (8.8% of the sample) are neutral (M = 4.453; SD = .653). Referring to control group, as shown in table 1, 171 respondents (83.8% of the sample) claim that student-centered teaching approach is never or occasionally used, 14 respondents (6.9% of the sample) claim often, and 18 respondents (8.8% of the sample) are neutral (M = 1.719; SD = .892). This result means that the student-centered teaching approach is used approximately in most of the lecturing time of the experimental group and very little in lecturing time of the control group.

Problem-based learning

Table 2: Problem-based learning frequencies

		Problem- based learning Experimental group		Control group	
		Frequency	Percent	Frequency	Percent
Valid	1.00 Never	53	24.7	69	33.8
	2.00 Ocassionally	83	38.6	102	50.0
	3.00 Neutral	19	8.8	18	8.8
	4.00 Often	25	11.6		
	5.00 Very often	34	15.8	14	6.9
	Total	214	99.5	203	99.5
Missing	System	1	.5	1	.5
Total		215	100.0	204	100.0

Related to the experimental group, as shown in table 2, 136 respondents (63.3% of the sample) claim that problem-based learning is never or occasionally used, 59 respondents (27.4% of the sample) claim often or very often, and 19 respondents (8.8% of the sample) are neutral M = 2.551; SD = 1.392). Referring to control group, as shown in table 2, 171 respondents (83.8% of the sample) claim that problem-based learning is never or occasionally used, 14 respondents (6.9% of the sample) claim very often, and 18 respondents (8.8% of the sample) are neutral (M = 1.957; SD = 1.025). This result means that problem-based learning is used relatively a little in lecturing time of the experimental group and very little in lecturing time of the control group.

Academic achievement

Table 3: Academic achievement frequencies

		Academic achievements Experimental group		Control group	
		Frequency	Percent	Frequency	Percent
Valid	1.00 Very low level	31	14.4	38	18.6
	2.00 Low level	51	23.7	62	30.4
	3.00 Medium level	61	28.4	44	21.6
	4.00 High level	56	26.0	51	25.0
	5.00 Very high level	15	7.0	8	3.9
	Total	214	99.5	203	99.5
Missing	System	1	.5	1	.5
Total		215	100.0	204	100.0

Concerning experimental group, as shown in table 3, 82 respondents (38.1% of the sample) claim that academic achievement is ranked in very low and low level, 71 respondents (33.0% of the sample) claim in high and very high levels, and 61 respondents (28.4% of the sample) in medium level (M = 2.873; SD = 1.161). Related to control group, as shown in table 3, 100 respondents (49% of the sample) claim that academic achievement is ranked in very low and low level, 59 respondents (28.9% of the sample) claim in high and very high levels, and 44 respondents (21.6% of the sample) in medium level (M =

2.650; SD = 1.160). This result means that academic achievement is ranked mostly in medium and high levels of the experimental group, and mostly very low, low and, medium levels of the control group.

Inferential statistics

Test of Hypothesis # 1

Table 4: Pearson correlation coefficients of experimental group

Correlations

		Academic achievements	Science student-centered teaching approach	Problem- based learning
Pearson Correlation	Academic achievements	1.000	.144	.487
	Science student- centered teaching approach	.144	1.000	-.039
	Problem- based learning	.487	-.039	1.000
Sig. (1-tailed)	Academic achievements	.	.018	.000
	Science student- centered teaching approach	.004	.	.287
	Problem- based learning	.000	.287	.
N	Academic achievements	214	214	214
	Science student- centered teaching approach	214	214	214
	Problem- based learning	214	214	214

Related to the experimental group, as shown in Table 4, there is a low positive correlation between student-centered teaching approach and academic achievement variables, r = 0.144, n = 214, p <0.005, where increases in student-centered teaching approach values were associated with increases in academic achievement values. Related to the control group, as shown in Table 5, there is a relatively low positive correlation between student-centered teaching approach and academic achievement variables, r = 0.292, n = 203, p <0.005, where increases in student-centered teaching approach values were associated with increases in academic achievement values.

Test of Hypothesis # 2

Table 5: Pearson correlation coefficients of control group

Correlations

		Academic achievements	Science student-centered teaching approach	Problem- based learning
Pearson Correlation	Academic achievements	1.000	.292	.315
	Science student- centered teaching approach	.292	1.000	.543
	Problem- based learning	.315	.543	1.000
Sig. (1-tailed)	Academic achievements	.	.000	.000
	Science student- centered teaching approach	.000	.	.000
	Problem- based learning	.000	.000	.
N	Academic achievements	203	203	203
	Science student- centered teaching approach	203	203	203
	Problem- based learning	203	203	203

Related to the experimental group, as shown in Table 4, there is a medium positive correlation between problem-based learning and academic achievement variables, r = 0.487, n = 214, p <0.005, where increases of the problem-based learning and academic achievement values were associated with increases in academic achievement values. Related to the control group, as shown in Table 5, there is an under medium positive correlation between problem-based learning and academic achievement variables, r = 0.315, n = 214, p <0.005, where increases of the problem-based learning and academic achievement values were associated with increases in academic achievement values.

Test of Hypothesis # 3
Experimental group

Table 6: Multiple regression coefficients of experimental group

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.514[a]	.264	.257	1.00174	.264	37.797	2	211	.000

a. Predictors: (Constant), Problem- based learning , Science student- centered teaching approach

Related to experimental group as shown in Table 6, the total variance of academic achievement levels explained by student-centered teaching approach and problem-based learning (the model) is 26.4%, F (2, 37.797), p < 0.005, the other variance may be explained by other variables. In the model, the control measure is statistically significant recording higher standardized beta values for student-centered teaching approach: beta = 0.163; p < 0.005), and for problem-based learning: (beta = 0.493; p < 0.005). The total variance of academic achievement levels explained by the student-centered teaching approach separately is 2.65%, F (2, 37.797), p < 0.005, and explained by the problem-based learning separately is 24.3%, F (2, 37.797), p < 0.005.

Control group

Table 7: Multiple regression coefficients of control group

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.346[a]	.120	.111	1.09431	.120	13.639	2	200	.000

a. Predictors: (Constant), Problem- based learning , Science student- centered teaching approach

Related to control group as shown in Table 7, the total variance of academic achievements levels explained by student-centered teaching approach and problem- based learning (the model) is 12.0%, F (2, 37.797), p < 0.005, the other variance may be explained by other variables. In the model, the control measure is statistically significant recording higher standardized beta values for student-centered teaching approach: beta = 0.171; p < 0.005), and for problem- based learning: (beta = 0.223; p < 0.005). The total variance of academic achievement levels explained by the student-centered teaching approach separately is 2.92%, F (2, 37.797), p < 0.005, and explained by the problem-based learning separately is 4.97%, F (2, 37.797), p < 0.005.

DISCUSSION and CONCLUSION

This study aimed to investigate the effects of student-centered teaching and problem-based learning on academic achievement. The prior assumption was that student-centered teaching and problem-based learning influence academic achievement in science teaching.

The results of the first hypothesis indicated that there is a low positive correlation between the student-centered teaching approach and academic achievement related to experimental group (r = 0.144), as well as to control group (r = 0.292). The result was consistent with previously reported works, who argued that there is a significant positive relationship between student-centered teaching approach associated with high levels of academic achievement (Bagán, Sayós, and García, 2015; Hurney et al., 2011; Ashton, 2008; Dopico and Garcia-Vazquez, 2011; Zusevics et al., 2013; Jalali et al., 2012; Ahmad et al., 2011; Tripken, 2016; Ruiz-Martinez, 2013; Park, Park and Lee, 2009; An, Wilder and Lim, 2011; Duren and Cherrington, 1992; Thompson, 2015). In conclusion the first hypothesis, "there is a positive linear correlation between student-centered teaching and academic achievements in science teaching" is been supported.

The results of the second hypothesis indicated that there is a medium positive correlation between problem-based learning and academic achievements referring to experimental group (r = 0.487), as well as to control group (r = 0.315). The result was consistent with previously reported works, who argued that there is a significant positive relationship between problem-based learning and academic achievement (Grabau and Ma, 2017; Odom and Bell, 2015; Post et al., 2006; Stecker, Fuchs and Fuchs, 2005; Philip et al., 2008; Kitchen et al., 2007; Harris, 2009; Coca, 2012; Mello et al., 2017; Moutinho, Moura and Vasconcelos, 2017; Casanoves, 2017; Andersson and Reimers, 2009). In conclusion the second hypothesis "there is a positive linear correlation between problem- based learning and academic achievements in science" is been supported.

The results of the third hypothesis indicated that the student-centered teaching approach and problem-based learning influence strongly academic achievements related to experimental group (26.4%,) as well as to control group (12.0%,). Therefore, the student-centered teaching approach, and problem-based learning influence strongly academic achievement in science teaching. The result was consistent with previously reported works, who argued that student-centered teaching approach, and problem-based learning predict academic achievement (Rana and Dwivedi, 2017; Zuniga, 2015; Montrezor, 2016; Thoron and Myers, 2011; Poggi, Miceli and Testa, 2017; Briese and Jakubowsk, 2007; Alexander, 2013; Mohan, 2015; Hedley, 2013; Mackinnon, 2006; Margulies and Ghent, 2005; Swan et al., 2005; Ediger, 2018; Purser and Renner, 1983; Areepattamannil, 2012; Gao, 2014; Aslan, 2017; Ohle, Boone and Fischer, 2015; Ogonnaya et al., 2016; Karacop, 2017; Tatar et al., 2016; Dagher et al., 2004; Thomas and Strunk, 2017; Rodríguez et al., 2013; Raved and Assaraf, 2011; Nadelson, Walters, and Waterman, 2010; Fernandez-Santander, 2008; Paz-Albo, J., 2017). In conclusion the third hypothesis "student-centered teaching and problem- based learning predict academic achievements in science. The variance in academic achievements can be explained by scores on these two scales" is been supported.

Limitations and recommendations

One main limitation of the study should be acknowledged as part of the conclusions. The measurement of student-centered teaching, problem-based learning, and academic achievement variables is been made based on self-instruments.

The results of the study, supported by other researchers about the influence of student-centered teaching and problem-based learning on academic achievement have important implications for future research. Such research should investigate the influence of other variables on academic achievement. The results of this study also have important implications for practice. The important programs should be designed to develop and to support students and lecturers because it is confirmed by this study that student-centered teaching and problem-based learning strongly influence academic achievement. Overall, the findings of this study enhanced theoretical and practical understanding as a student-centered teaching approach and problem-based learning are important variables that support academic achievement.

Conclusion

The results showed that the student-centered teaching approach is used approximately in most of the lecturing times of the experimental group and very little in lecturing time of the control group. It is found that problem-based learning is used relatively a little in lecturing time of the experimental group and very little in lecturing time of the control group. The results showed that academic achievement are ranked mostly in medium and high levels of the experimental group, and mostly very low, low and, medium levels of the control group. There was a significant difference in student-centered teaching, problem-based learning, and academic achievement scores for experimental, and control group of students. At the same time, the magnitude of the differences in the means was large, so the experimental group of students performs better than the control group.

It is found that there is a low positive correlation between student-centered teaching and academic achievement, although there are significant differences between the experimental and control group. The study revealed that there is a medium positive correlation between problem-based learning and academic achievement, although there are significant differences between the experimental and control group. The study found that the total variance of academic achievement levels explained by student-centered teaching and problem-based learning is relatively a high percentage. This indicates that student-centered teaching and problem-based learning influence strongly academic achievement.

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