INTERNATIONAL JOURNAL OF ACADEMIC RESEARCH IN BUSINESS & SOCIAL SCIENCES
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ISSN: 2222-6990

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To Link this Article: http://dx.doi.org/10.6007/IJARBSS/v9-i12/6750 DOI: 10.6007/IJARBSS/v9-i12/6750

Received: *10 November 2019,* ***Revised:*** *28 November 2019,* ***Accepted:*** *09 December 2019*

Published Online: 30 December 2019

In-Text Citation: (Bani-Hamad & Abdullah, 2019)

To Cite this Article: Bani-Hamad, A. M. H., & Abdullah, A. H. (2019). Developing Female Students' Learning and Innovation Skills (4cs) In Physics through Problem Based Learning. *International Journal of Academic Research in Business and Social Sciences*, *9*(12), 560–572.

Vol. 9, No. 12, 2019, Pg. 560 – 572

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ISSN: 2222-6990

Developing Female Students' Learning and Innovation Skills (4cs) In Physics through Problem Based Learning

Adwan Mohammad Hasan Bani-Hamad, Professor Dr. Abdul Hakim Abdullah

Faculty of Islamic Contemporary Studies, Universti Sultan Zainal Abidin, Gong Badak Campus, 21300 Kuala Terengganu, Malaysia.

Email: adwan.banihamad@yahoo.com, hakimabd@unisza.edu.my

Abstract

Through teaching physics, students still lack in 21st century skills especially, learning and innovation skills which are important to their future careers and daily life. Educators reported a lot of teaching strategies providing opportunities for authentic learning activities that acquire students these future skills includes problem based learning strategy. Unfortunately most previous studies concentrated on male students and on higher education institutions ignoring the school students especially, female school students who need exposure for these real activities to prepare them for university study. The present study aimed to investigate the effect of problem-based learning on female students' learning and innovation skills-4Cs while teaching physics. The sample included 45 grade 11 female students selected purposively from Dayr Abu Saeed secondary school for girls in Jordan, which distributed into two groups: an experimental group consists of 22 students taught the physics unit by problem-based learning method and control group comprises 23 students taught the same physics unit by conventional method. A quasi-experimental research design was administered. Learning and innovation skills test was prepared by the researcher and used to collect data. A pre-test was administrated before the students have begun the treatment and post-test after they have finish. Descriptive statistics for the variables treated was run and Independent sample T-Test for the post-tests to answer the study question. Results showed a significant difference in students' learning and innovation skills (4Cs) test in favor of experimental group, the experimental group performed better in post-test. In other words, problem-based learning is able to develop on learning and innovation skills (4Cs) among female secondary level students.

Keywords: Collaboration and Communication Skills, Creative Thinking, Critical Thinking, Learning and Innovation Skills, Problem-Based Learning.

Introduction

Education does a significant role in preparing students for the community they live. In the past, students were provided with basic skills to fill a role that includes cognitive labor or routine jobs. However, the present economy and industries are altogether different. computers and machines can do work that has used a large part of the population, thus, individuals are utilized in occupations that require higher-order thinking, communication, or collaboration abilities - which Computers and machines cannot do (Dede, 2010). As well as today, success also lies in the ability to share information, communicate and use it to solve problems, adaptability and innovation in response to new changing circumstances, and the ability to lead and create new knowledge (Pacific Policy Research Center, 2010).

In addition, to the fast improvement of technology, the world is changing more rapidly than previously. As a result, it is important to empower students not only with academic content knowledge, but also with skills that will enable students to face 21st challenges century with confidence. Students are no longer sufficient in mathematics and literacy; students need to have more tools at their disposal. These tools generally come in the form of higher-order thinking, collaboration and communication skills, called learning and innovation skills which referred to 21st century skills (Trilling & Fadel, 2009).

Accordingly, todays' students should be capable in reading, writing, and arithmetic, yet additionally in critical thinking, creative thinking, and oral and writing communication, and work effectively in the team, so they are prepared for a workforce that requires higher-order thinking and communication skills (Dede, 2010). Therefore, students need to have various 21st century skills especially, learning and innovation skills beside to basic content knowledge of subject matter in order to success in the new world.

Physics is one of the departments of science that endeavors to describe how nature functions utilizing mathematics' language. It includes the investigation of widespread laws and the practices and relationships among a wide range of physical phenomena (Argaw et.al, 2017). Teaching physics allows the students to acquire skills and understanding scientific knowledge needed for scientific research (Minishi et.al, 2004; Bani-Hamad, 2017; Barahmeh et al., 2017). Because students interest to learn physics, the present discussion is to decide the ideal manner by which they learn and acquire 21st century skills. Pacific Policy Research Center (2010) suggests the best practices for implementing learning and innovation skills is problem-based learning, to prepare our students for future work and careers. So, the present study aimed to investigate the effect of problem-based learning on female students' learning and innovation skills (4Cs) of physics which are considered as a part of important 21st century skills.

Problem Statement

Based on society's needs it is clear that the learning and innovation skills need to be improved into teaching physics in the classroom to acquire students with adequately skills to equip them for the study in the university and daily life (Partnership for 21st Century learning , 2009). As well as by educator's experiences there is lake of 21st century skills among students. In addition, teachers still use traditional methods by explained too much and gives definitions, concepts, and

formula. In contrast, students need opportunities to solve problems (Malmia, et al., 2019). Consequently, developing physics education strategies in better way and improve students with future skills becoming one of the main issues that educators deal with in physics education (Argwa et al., 2017; Barahmeh et al., 2017). Furthermore, most previous studies (i.e Borhan (2014); Othman, et al.(2014); Megan & Henk (2015); Siew& Mepeala(2016); and Argwa et al.(2017) that regard of problem-based learning strategy concentrated on male students and on higher education institutions (universities) ignoring the school students especially, female school students Therefore, this study comes to investigate the ability of developing learning and innovation skills (4Cs): (Communication, Collaboration, Critical thinking, Creative thinking) through problem-based learning strategy among a sample of female secondary level students who participate in this study.

Research Question and Hypothesis

This research attempted to answer the main study question: What is the effect of using problem-based learning in the development of learning and innovation skills (4Cs) among female secondary level students? Of which the following question can be derived:

Q: Are there a significant differences (α =0.05) in the post-test for the learning and innovation skills (4Cs) for physics between experimental and control groups, due to the problem-based learning strategy?

Null Hypothesis

H0: There is no significant differences between experimental and control groups in the learning and innovation skills (4Cs) for physics due to problem-based learning.

Study Objective

The study aimed to investigate the ability of developing learning and innovation skills (4Cs): (Communication, Collaboration, Critical thinking, Creative thinking) through problem-based learning strategy among a sample of female secondary level students who participate in this study.

Definition of Terms

Problem-Based Learning

PBL is an educational strategy that gives students with authentic learning opportunities focusing on teaching through real-life situations and tackling real world issues. Where teacher provide a situation that their student interest in or solve those problems, test their answers, and impart the outcomes. Through those procedures PBL, learners not just gain content knowledge, but they improve their learning and innovation abilities. Moreover, PBL is profoundly student-centered and includes creating their learning and improving their own knowledge through teacher guide, not teacher lessons. as well as in PBL students must learn how to utilize information in new and creative ways and create their own ideas by trying to solve a problem that face them in their lives

(Prettyman et al., 2012; Othman, et al., 2014; Megan & Henk, 2015; Siew & Mapeala, 2016; Argaw et al., 2017; Malmia, et al., 2019)

Learning and Innovation Skills - 4Cs

A set of important abilities for prosperity and success in a complexity world; present high-order thinking and social skills which are encourage lifelong learning, which make students more responsive with changes that face them in their lives. As well as consider student-centered skills such as creative thinking, critical thinking, innovation, collaboration, responsibility, and communication (Partnership for 21st Century learning, 2009; Dede , 2010; National Research Council, 2013) That were used and enhanced in problem-based learning strategy.

Limitations

Study results can be limited by the following factors: Firstly, the study sample was 45 grade 11 female secondary level students in 2018- 2019 school year. Therefore, the gender could have affected the result of the study as the study was conducted strictly on female students only. The second limitation is the researcher discussed and examined only the learning and innovation skills 4Cs; the final limitation is the educational material on wave motion of physics unit of study eleven grade's physics textbook.

Literature Review

Problem- Based Learning

The notion of Problem based learning (PBL) is not new idea. Moreover, this idea do not much changed since long time. This conception was used much in medical education nearly 50 years ago and still adopted today as a teaching method of educational fields and levels to supply the learners with real learning experiences and to help in development life and career skills like creativity, critical thinking, communication, and collaboration (Barrows & Tamblyn, 1980; Vega & Brown, 2013; Othman, et al., 2014; Siew & Mapeala, 2016). PBL was designed support therapeutic projects when instructors discovered that people were graduating with a lot of knowledge but without the need of problem solving or basic skills to use the knowledge with sagacity (Vega & Brown, 2013; Masitoh & Fitriyani, 2018).Through teaching learners by PBL instructions they were better ready to be higher thinker, solver problems, and interacting with sick people wisely. After accomplish in the medical field. PBL started to be as an effective strategy in all education fields.

PBL was like a powerful and innovative teaching strategy and essential to study learning due to this strategy taught students in a full range of authentic life activities by utilizing a practical training approach (Kelly, 2012, 2014; Siew & Mapeala, 2016). It was a great idea if these activities might be a base to merge multiple academic contents and integrate issues that affect or interested students (Othman, et al., 2014; Kelly, 2014). In other words, learning academic contents through practical training make the information more pertinent to their students.

Dewey debate that students will develop personal investment in the material if they share in real, meaningful tasks and problems that emulate what experts do in real-world positions. At the last

two decades, learning sciences researchers have improved and elaborated Dewey's original insight that activate inquiry results in deeper understanding. New discoveries in the learning sciences have led to new ways of understanding how students learn (Krajcik & Blumenfeld, 2006; Siew & Mapeala, 2016; Kim, et al., 2018). Constructivism believes that meaning is formed when engaging in a real experience. Teachers, who rely heavily on course materials, provide students with only one aspect of the real complex (Brooks & Brooks, 1999; Kafi & Motallebzadeh, 2014). Therefore, a student's success in the 21st century largely depends on much critical thinking they are and how much they can solve problems that face them in their life (Kafi & Motallebzadeh, 2014).

Ohlsson (2012) proposed some practical ways to develop real-world problem solving skills. Inquiry-based learning is similar to real-world problem solving, in which knowledge is presented to students in a type of scaffolding way. As well as this, some points should be taking account when using real-world problem solving: The problem should be presented in a real way, students should work collaboratively, and students should be able to apply their knowledge to the current problem and evaluate their learning (Hung, 2002; Borhan, 2014).

Problem-based learning is another form of inquiry-based learning, firmly rooted in constructivism (Duffy, 2004). By implementing problem-based learning, we are preparing our students to face the 21st century confidently and a repertoire of skills they can use successfully (Bell, 2010).

Learning and Innovation Skills

21st century skills include wide range of skills and abilities necessary to succeed in the future careers and daily life (Dede, 2010; National Education Association (NEA). Learning and innovation skills are part of the global framework which was prepared through Partnership for 21st Century learning (P21). A Learning and innovation skills (4Cs) includes creative thinking, critical thinking, communication, and collaboration as follow:

Communication and Cooperation

Partnership for 21st Century skills (2009); Trilling & Fadel (2009); Anagün (2018); National Education Association (NEA) suggest that students nowadays must be able to: Express ideas and beliefs effectively using oral, written and non-verbal communication skills in a variety of forms and contexts; Listen carefully to understand the meaning, including: knowledge, values, attitudes and intentions; Communicate for a variety purposes, for example to inform, guide, motivate and persuade. Use multiple media and techniques and know how to judge their effectiveness a priority, and communicate effectively in diverse environments. Additionally, demonstrate the ability to work effectively and respectfully with diverse teams; exercise elasticity with readiness to help make necessary compromises to achieve a common goal; take joint responsibility for cooperation work and the value of individual contributions made by each team member. Partnership for 21st Century learning (2009) emphasize that communication and cooperation skills can be learned by a variety ways, such as problem-based learning, and problem solving.

Critical Thinking

Critical thinking skills consist of the ability of individuals to reason effectively, analyze, interpret, summarize and evaluate alternative perspectives, and reflect critically on decisions and processes. The P21 initiative places particular emphasis on students`' ability to: Reason effectively and utilize systems thinking; make judgments and decisions (Partnership for 21st century skills, 2009; Trilling & Fadel, 2009; & Pacific policy Research Center, 2010; Anagün, 2018).

Creativity and Innovation

Partnership for 21st Century skills (2009) defines creativity as learners think creatively by using and creating a wide range of ideas; detailed, cultivate, construe, and valuation original ideas to improve and maximize creative efforts. In addition, implement innovation through work on creative ideas to make a tangible and useful contribution in the area where innovation will take place.

The skills characterized above are important to ensure the students dominance of 21st century. Educational plan, curriculum and learning situations must be adjusted to produce a supportive system that will prompt the 21st century results for the present students Anagün, 2018).

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Research Methodology

To achieve the aim of this study, a quasi-experimental research design was used. The independent variable in this research is teaching instruction: Problem based learning (PBL) and traditional method, and the dependent variables are students' learning and innovation skills.

Instrumentation

To get the required result based the research question that specified in the study which was related to possible significant effects of problem-based learning on the learning and innovation skills (4Cs) among female 11 grade, the study designed a modified learning and innovation skills test based on al-Baz (2016), 21st century skills test in science, the test comprises 20 multiple choice questions divided: five questions in each about Creative Thinking; Critical Thinking; Communication skills; and Collaboration skills to be applicable for the present study and appropriate for Jordanian secondary students, which aimed to elicit the aforementioned skills. The test was administered by 20 female grade 11 Students as a pilot study, its reliability was checked, which reached 0.89. Furthermore, the test validation was checked by science education and psychological experts from Yarmouk University. About 45 minutes allocated for answering the pre learning and innovation skills test, and 45 minutes for post-test in the class.

Participants

The study sample selected purposively from Jordanian female secondary school level students who studying at Dayr Abu Saeed school for girls in the school year 2018- 2019, where this school was intentionally chosen due to: the school has six sections of 11 grades which give the freedom to choose the sample. As well as the full readiness of administrators in the school to cooperate with researcher and physics teachers' desire for cooperation and application of this study. Prior

to the beginning of treatment, a similar test was conducted to test learning and innovation skills for all classrooms 11 at the school (six sections). According to the result, three sections (groups) found with approximately the same average value. According to that, in this study two groups chosen randomly; experimental group 22 students and control group 23 students. The table 1 illustrates the study sample.

Table 1
Sample distribution by group

Groups	N	Gender	Total
Experimental Group	22	Female	45
Control Group	23	Female	

After the sample has chosen, pre learning and innovation skills (4Cs) test administered on both experimental and control groups to assure groups equivalence.

The table 2 shows the mean scores and standard deviation for each group and independent sample T-Test between the two groups on pre-test.

Table 2
Mean and test statistics of pre-test learning and innovation skills for the two groups' students

Group	N	MEAN	S.D	T-test	Sig.	DF
Experimental	22	9.10	1.98	0.785	0.506	43
Control	23	9.76	2.13			

Mean scores for both PBL and traditional group are 9.10 and 9.76 respectively. As well as the value of t (0.785), P = 0.506> 0.05, which indicates no statistically significant differences exists in the two group students pre-test of learning and innovation skills test between PBL and traditional group, in other words, the two groups are equivalent in learning and innovation skills in the pre- test.

Procedures

To carry out this study, the physics unit in grade 11 textbook has chosen to let the teacher teach this unit by problem based learning strategy. The unit was wave motion. The teacher who taught the experimental group was graduated from the university in master degree and he is expert in using modern strategies in teaching physics. The teacher has trained at prepare problems related to the lessons in text book and how to use problem-based learning strategy with his group.
Therefore, the teacher began teach the physics unit confidently. As well as the treatment continues about four weeks. The control group taught the same physics unit by conventional

method. After the treatment with experimental group was completed, the two groups took the same learning and innovation skills test which used as pre-test previously in the study but works here as the post- test with 45 minutes to find out whether their learning and innovation skills (4Cs) had significantly changed after the experimental group and control group finished or not. Later on quantitative information obtained was used in the analysis of the results. Finally, the data were analyzed by SPSS software and more specifically independent sample T-Test to gain results.

Findings and Discussions

Based on the research question which was mentioned previously i.e. whether or not problem-based learning can significantly develop the learning and innovation skills (4Cs) among Jordanian secondary level students, descriptive statistics for the variables was carried out through SPSS software.

Table 3

Descriptive facts to the variables dealt with in the study

variable	Experimental group (n=22)				Control group (n=23)			
	Pre-test		Post-test		Pre-test		Post-test	
	M	SD	M	SD	M	SD	M	SD
learning and innovation skills test	9.10	1.98	14.86	2.14	9.76	2.13	10.23	2.65

The findings according to the table 3 shows the mean result of the experiment group on the learning and innovation skills test when it tested before the experiment (9.10) and that of the control group (9.76) was approximately similar. This point to investigate was the starting the effect of treatment (PBL) after the intervention. Post test results showed that the two groups changed noticeably especially in experimental group the increase was much better than comparison group; 14.86 mean score the experimental result group and 10.23 mean score for control groups.

In addition, independent sample T- Test was run to identify the statistics considerable differences for the post test between the two groups and to accept or reject the null hypothesis which stated: There is no significant difference between experimental and control groups in the learning and innovation skills (4Cs) test for physics due to problem-based learning.

Table 4 below illustrates the independent sample T -Test for two groups post test

Table 4

Independent sample T Test for post-tests in the learning and innovation skills (4Cs).

Group	N	MEAN	S.D	T-test	Sig.	DF
Experimental	22	14.86	2.14	0.632	0.000	43
Control	23	10.23	2.65			

Table 4 revealed that there are significant differences between the mean scores of respondents in post-tests in the Experimental and control groups, where the students performed more significantly in post-test in experimental group than in post-test for comparison group i.e. (Sig. = 0.00 < 0.05) in learning and innovation skills (4Cs) tests. A significant difference was observed regarding the respondents mean scores as the post-test which was done after the treatment showed that students did perform better than in pre-test before treatment. Consequently, the problem-based learning strategy had a significant effect on the improvement of learning and innovation skills among female grade 11 students who participated in study. Therefore, this aligned with most studies which investigated the impact of problem- based learning on 21st century skills, where the results in these previous studies showed that students did better in post-test than in pre-test.

Conclusion

The objective of this study was to investigate the ability of developing learning and innovation skills (4Cs) through problem-based learning strategy among a sample of female secondary level students. Pre and post-tests had used to collect data. The findings of the study have met the study objectives as shown in tables 3 and 4. The study results yield that student' mean scores on learning and innovation skills (4Cs) test after implementing PBL had a significant position. Consequently, the problem-based learning strategy had a significant effect on the development of learning and innovation skills (4Cs) among female grade 11 students. In addition to this, the study recommends to expand uses of PBL with all students' levels and with other school subjects in schools in order to develop future skills in our students which they need in daily life and university's study. Furthermore, this study will serve for future researches on the effects of problem based learning strategy in teaching physics on developing learning and innovation skills among Jordanian female students.

It is recognized that students still lack of learning and innovation skills especially in learning physics, the need to empower students with creative thinking, critical thinking, communication, and Cooperation skills from 21st century skills is necessary and important for students to prepare them for future jobs and university's study especially school students by provide opportunities for authentic learning activities, according to the findings of the current study, PBL strategy is able to do this role, might increase in learning and innovation skills during problem-solving tasks. This suggests the PBL may be most effective as students are asked to work on real life problems. They are also having opportunities to think critically and creatively and learn how to propose solutions to problems by communication and collaboration skills.

Contribution of the Study

The findings of the study present theoretical Contribution through supporting theories and literature that related of PBL approach such as constructivism theory and PBL in developing the learning outcomes and students' problem solving skills. The findings have supported the hypothesis and objective of the study. This study also attempted to determine the applicability of implement the problem based learning strategy in the schools with female students effectively. This study has contribution for stakeholders in Ministry of Education in Jordan

regarding how to develop learning and innovation skills and encouraging effective implementation of PBL in schools. In addition, this study recommends modify Jordanian teachers' traditional role in the classroom to give students opportunities to become more thinkers and independent learners. Moreover, this PBL approach will influence in students' performance daily life and future careers especially female students in secondary schools. As well as the future researches will benefit from methodology and results for this study.

Acknowledgement

This study was conducted in Dayr Abu Saeed secondary school for girls. I would like to thank all staff of the school especially the principal and science teachers section for important and value suggestions and efforts while work is underway. Finally, I like to send an appreciation for all lecturers in Yarmouk University for their judgments of the instrument and their valuable comments to modify the instrument and reviewer this article for his/her insightful comments and suggestions.

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