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The Effectiveness of Project – Based Learning (Egg Drop Project) Towards Students' Real World Connection in Learning Physics

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ABSTRACT: *The purpose of this research was to seek the effectiveness of Project – Based Learning (PBL) (i.e., egg drop project) towards students' real world connection in learning physics. This research was conducted in Tuaran (Urban) and Kota Marudu (Rural) in Malaysia. A total of thirty- eight(38) form four students (i.e., 17 male and 21 female students) were used in the study. Data used in the study were collected using the Colorado Learning Attitude about Science Survey (CLASS) – real world connection Category. Respondents were required to response to the survey instrument based on a five point Likert scale before (pre-survey) and after (post-survey) in the implementation of PBL. Data collected were analysed using Statistical Package for Social Science Version 20.0 for windows (SPSS) to compare the students' pre-survey and post-survey responses. Wilcoxon signed ranks test results showed that real world connection of overall students for both schools in total, gender (i.e., male and female) andlocation(i.e., urban and rural) have positive significant difference in median values.In addition the second analysis which is the paired samples-t-test results showed that overall students for both schools in total, gender (i.e., male and female)and location (i.e., urban and rural) have positive significant difference in mean values as well. Therefore study revealed that through PBL-egg drop project, students could relate physics concepts; momentum, impulse and impulsive force into real life situations, engaged students' real world connection in learning physics and changed students' perception towards physics.*

Keywords: *Project-Based Learning, Physics Education, Egg Drop Project, Real World Connection*

I. Introduction

Abilities to make connection with real life situations are important for students to prepare themselves for their future career as these abilities are required by the industries who want skillful individual to work in complex thinking environments (Azura, Farizah& Ida, 2012). Science curricula implemented in school always received criticism as not providing students with enough experience with real world problems which in science curricula solely focus on well-defined problems that only have one solution and teaching students how to get the correct answer (Laboy – Rush, 2011). Many students who enrolled in physics related course think and say, physics is difficult to learn and understand (Angell, Guttersrud, Henriksen&Isnes,2004).Female students found out that physics subject are irrelevant in connection with daily life situation in comparison with male students (Williams, Stanisstreet, Spall, Boyes& Dickson, 2003). Meanwhile, urban physics teachers involved more real world - life experience in their physics pedagogy in comparison with the rural physics teachers (Ramsey, Nemeth &Haberkorn, 2013).

When students come to the course with more real world connection are likely to have higher learning gain (Perkins, Adams, Pollock, Finkelstein &Wieman, 2004). Hands on activities for physics in everyday life course give a positive effect towards students' real world connection (Harlow, Landau & Bailey, 2014). Physics teaching strategies that involved real world applications and connection to careers give positive impact on male and female students' desire to learn more (Lock, Castillo, Hazari&Potvin, 2015).

II. Literature Review

The obvious factor makes physics difficult on the students' view are physics irrelevant to learn with the connection of everyday life and the more the students learn about physics the more boring they will get (Erinosho, 2013). Traditional approach in teaching physics has been used for a long time not just in secondary school level but as well as university level (Wang, 2005). In traditional approach, teacher plays an important role where teacher provides information, material and note taking (Castillo, 2010). Students hard to connect what they learn in class with the real life through traditional approach which information always have been delivered superficially as much of the content is too abstract (Wang, 2005).

For the past twenty- five years, constructivism is getting more attention as a teaching method practice in education at school after educators frustrated with traditional approach that fails to give positive effects on students learning in classroom (Jones &Araje, 2002). Constructivism emphasises more on to construct knowledge rather than to transmit and record information given from another person (Applefield, Huber

&Moallem, 2001). Students build their new knowledge based on incorrect, partial or irrelevant existing knowledge (Taber, 2011).

Project-Based Learning (PBL) is adopted constructivist learning theory where students construct their own knowledge based on experience through actual projects (Holubova, 2008). In addition, PBL serves with real world projects that connect students with daily life situations that help students to achieve high standards in education (Emanuel, Joyner, Bradby, Creech & Bottoms, 1998). Students agree that PBL helps them to connect and relate physics concept with real world applications (Liu, 2014; Borovoy, 2014).

Female students are impacted more with PBL compared to male students which female students have higher response regarding PBL that served effectively to connect with the real world (Vaz, Quinn, Heinricher&Rissmiller, 2013). Meanwhile, male and female showed positive contribution towards their real world connection in physics engineering after intervention of PBL (Zastavker, Ong & Page, 2006). Through PBL, rural students appreciate more about the important of science and the application of science with the real world (Muzzarelli, 2007). Urban students can excel in their examinations and assessments as urban students are exposed with real situations through the implementation of PBL that involve in their learning process in class (Emanuel, Joyner, Bradby, Creech & Bottoms, 1998; Pelech, 2008).

In PBL, teacher acts as a facilitator and provide hands-on activities that focuses on students' learning towards issues of problems and topic that not included in the textbook (Holubova, 2008). Moreover, teacher needs to choose projects that can influence students' engagement to develop their interest and able to relate project with real life situations (Subramaniam, 2009).

Egg drop challenge is part of *Drexel-SDP GK-12- activity in* Drexel University, Philadelphia, USA to excel in Astronomy Module two which students act as a Mars Rover Engineers to drop and landed the rover on the planet from a spacecraft safely (Kusic&Garbarine, 2008). According to Lost Angeles Unified School District, USA (2012), egg drop project helps students to enhance their understanding towards physics especially momentum and impulse concept. Hands-on projects such as egg drop project helps students to have better understanding in physics where students work in teams and build egg container using balsa wood sticks, glue and raw egg and drop the unit from a certain height and place on a target zone (Sridhara, 2013). This project is a great success as students can relate their understanding more about the concepts into real life situations which students free to apply their own skills and knowledge to design and build the egg's protector instead of taking order from manual book (Yusfi, 2014).

Research Objectives

The main objectives of this study were:

- To compare students' real world connection towards physics before and after the implementation of Project-Based Learning (egg drop project).
- To compare male and female students' real world connection towards physics before and after the implementation of Project-Based Learning (egg drop project).
- To compare urban and rural students' real world connection towards physics before and after the implementation of Project-Based Learning (egg drop project).

III. Research Methodology

This study employed a quantitative approach in its methodology and designs with pre-survey - post-survey administered to the experimental group and none to the control group (Encyclopedia of Research Design, 2010). Sample collected from two schools situated in Tuaran District which represented an urban area (School A) and Kota Marudu District which represented a rural area (School B). Thirty – eight (38) Form Four (4) science students were involved in this study who took physics. As students were the respondents for this research, data could be extracted from two different places to measure the effectiveness of the implementation of PBL to improve students' real world connection towards physics. Researcher used the same methodology for both schools for this study. Table 1 showed the overall total of sample in both schools:

Table 1: Students' Distribution from Both Schools

School	Gender		Total
	Male	Female	
A	8	12	20
B	9	9	18

Survey Questionnaire

According to Adams, Perkins, Podolefsky, Dubson, Finkelstein &Wieman (2006), students' real world connection in physics can be measured using The Colorado Learning Attitude about Science Survey (CLASS) –

real world connection category. Four (4) statements of CLASS – real world connection category are listed below:

- *Learning physics changes my ideas about how the world works.*
- *Reasoning skills used to understand physics can be helpful to me in my everyday life.*
- *The subject of physics has little relation to what I experience in the real world.*
- *To understand physics, I sometimes think about my personal experiences and relate them to the topic being analyzed.*

Each item statement was based on a five-pointLikert Scale as follows: Strongly Agree-5; Agree-4; Neutral-3; Disagree-2; and Strongly Disagree-1 (Adams, Perkins, Podolefsky, Dubson, Finkelstein &Wieman, 2006). All four (4) statements passed the reliability and validity tests conducted by the University of Colorado Physics Education Research Group (Mistades, Reyes &Scheiter, 2011). Each item statement was translated to Malay Language in this study. Before the intervention, a pilot test was conducted and the Cronbach's Alpha (α) coefficient value for CLASS – real world connection category was $\alpha = 0.746$. Result revealed that CLASS – real world connection category instruments were reliable to be used in the data collection. Students conducted the pre-survey and post-survey before and after the intervention by using exactly the same questionnaires.

Implementation of Project-Based Learning (Egg Drop Project)

Students worked in a group project where each group consisted of three (3) or four (4) students. Students relate the physics concepts within the physics curriculum content namely as momentum, impulsive and impulsive force to build an egg protector by using the fundamental materials such as toothpicks, superglues and a raw egg provided by the facilitator. Each group was given two weeks to design and build the egg protector, discuss project-related issues and questions among group members and the facilitator. At the end of the twoweeks, students present their best model of the project and egg drop launching session was conducted from the two-level of building block. Each group need to make sure the raw egg not break after landed on the ground.

IV. Results And Discussion

Students' Real World Connection towards Physics

Parametric analyses can be performed well with continuous data which obtained from small samples greater than twenty (20) (Frost, 2015). At the same time, it is best to employ the 'paired- samples t-test' if the data is in normal distribution, and the 'Wilcoxon Signed Rank test' if the distribution is not normal and in a small number of the sample to investigate differences between groups (Coakes, 2005). In this study, Wilcoxon signed ranks test was used to analyse the median data and paired sample t-test to analyse the mean data (Frost, 2015). Statistical Package for Social Science Version 20.0 for windows (SPSS) was used to analyse the data.

Wilcoxon signed-ranks test results in Table 2 showed that overall students for both schools in total have a statistically significant difference between the median value Likert scale for post-survey and pre-survey (Z = -5.06, p = 0.00*). Indeed, median value for post-survey was 4.25 and pre-survey was 3.38.

Paired samples *t*-test results in Table 2 revealed that overall students for both schools in total have a statistically significant difference between the mean value level Likert scale degree of agreement of post-survey (M = 4.17, SD = 0.45) and pre-survey (M = 3.49, SD = 0.43) that the students have, t (37) = 8.95, p = 0.00*, $p \leq 0.05$.

Table 2: Results on Students' Real World Connection for Both Schools in Total

Likert Scale Value	**Wilcoxon Signed Ranks Test**		**Paired Samples t-test**	
	Pre-survey	**Post-Survey**	**Pre-survey**	**Post-survey**
Mean			3.49	4.17
SD			0.43	0.45
Median	3.38	4.25		
Z / t value	Z = -5.06		t(37) = 8.95	
p – value	0.00*		0.00*	

*is significant at $p \leq 0.05$

Findings from this study show that PBL gives positive effect on students' real world connection towards learning physics after four (4) weeks of intervention. According to Emanuel, Joyner, Brad by, Creech & Bottoms (1998) stated that PBL serves with real world projects that connect students with daily life situations that help students to achieve high standards in education. In addition, these findings are in line with Borovoy (2014), which claims that students are more engaged in their learning with the world they live in with real world connections projects. Moreover, Simkins, Cole, Tavalin& Means (2002) claimed that project-based multimedia learning with strong real world connection, students have little to go wrong which students engage with the Project-Based Multimedia Learning, work hard and remember the experience for a long time.

Gender' Problem Solving Perception towards Physics

Wilcoxon signed-ranks test results in Table 3 showed that male students for both schools in total have a statistically significant difference between the median value Likert scale degree of agreement for post-survey and pre-survey (Z = -3.65, p = 0.00*). The median value for post-survey was 4.25 and pre-survey was 3.25. Meanwhile, female students for both schools in total have a statistically significant difference between the median value Likert scale degree of agreement for post-survey and pre-survey (Z = -3.42, p = 0.00*). The median value for post-survey was 4.00 and pre-survey was 3.50.

Paired samples t-test results in Table 3 revealed that male students for both schools in total have a statistically significant difference between the mean value level Likert Scale degree of agreement of post-survey (M = 4.34, SD = 0.36) and pre-survey (M = 3.44, SD = 0.45), $t(16) = 8.91$, p = 0.00*, $p \leq 0.05$. Meanwhile, female students for both schools in total have similar patterns with a statistically significant difference between the mean value level Likert Scale degree of agreement of post-survey (M = 4.04, SD = 0.48) and pre-survey (M = 3.52, SD = 0.43), $t(20) = 5.21$, p = 0.01*, $p \leq 0.05$.

Table 3: Results on Gender's Real World Connection for Both Schools in Total

Gender	Likert Scale Value	Wilcoxon Signed Ranks Test		Paired Samples t-test	
		Pre-survey	Post-survey	Pre-survey	Post-survey
Male (N=17)	Mean			3.44	4.34
	SD			0.45	0.36
	Median	3.25	4.25		
	Z/ t value	Z = -3.65		t(16) = 8.91	
	p – value	0.00*		0.00*	
Female (N=21)	Mean			3.52	4.04
	SD			0.43	0.48
	Median	3.50	4.00		
	Z/ t value	Z = -3.42		t(20) = 5.21	
	p – value	0.00*		0.01*	

*is significant at $p \leq 0.05$

These findings are not similar what has been reported by Williams, Stanisstreet, Spall, Boyes& Dickson (2003), stated that female students found out that physics subject was irrelevant in connection with daily life situation in comparison with male students. Findings in this study are in line with Zastavker, Ong & Page (2006), who done about exploring the effects of PBL in a first year undergraduates engineering programs, stated that male and female showed positive contribution towards their real world connection in Physics Enginnering after PBL. These findings are not in line with by Vaz, Quinn, Heinricher, &Rissmiller(2013), who done their study towards alumni engineering graduates in Worcester Polytechnic Institute, USA about the long – term impacts of PBL on engineering majors showed that female students are impacted more with PBL compared to male students which female students have higher response regarding PBL that served effectively to connect with the real world.

Urban and Rural Students' Problem Solving Perception towards Physics

Wilcox on signed-rank test results in Table 4 showed that urban students have a statistically significant difference between the median value Likert scale degree of agreement for post-survey and pre-survey (Z = -3.75, p = 0.00*). The median value for post-survey was 4.13 and pre-survey was 3.25. Meanwhile for rural students have a statistically significant difference between the median value Likert Scale degree of agreement for post-survey and pre-survey (Z =-3.45, p = 0.00*). Indeed, median value for post-survey was 4.25 and pre-survey was 3.75.

Paired samples t-test results in Table 4 revealed that urban students have a statistically significant difference between the mean value level Likert scale degree of agreement of post-survey (M = 4.13, SD = 0.48) and pre-survey (M = 3.29, SD = 0.42) that the students have, $t(19) = 7.02$, p = 0.00*, $p \leq 0.05$. Rural students have a statistically significant difference between the mean value level Likert scale degree of agreement of post-survey (M = 4.22, SD = 0.44) and pre-survey (M = 3.71, SD = 0.33) that the students have, $t(17) = 6.68$, p = 0.00*, $p \leq 0.05$.

Table 4: Results on Urban and Rural Students' Real World Connection

Students	Likert Scale Value	Wilcoxon Signed Ranks Test		Paired Samples t-test	
		Pre-survey	Post-survey	Pre-survey	Post-survey
Urban (N=20) School A	Mean			3.29	4.13
	SD			0.42	0.48
	Median	3.25	4.13		
	Z/ t value	Z = -3.75		t(19) = 7.02	
	p – value	0.00*		0.00*	
Rural (N=18) School B	Mean			3.71	4.22
	SD			0.33	0.44
	Median	3.75	4.25		
	Z/ t value	Z = -3.45		t(17) = 6.68	
	p – value	0.00*		0.00*	

*is significant at $p \leq 0.05$

These finding are in line with what reported by Harrigan (2014), stated that elementary teachers in Broward County Public School, Southern Florida, USA (urban school) agreed that PBL helped students to prepare themselves for the real world situations and for future job markets in the 21st century. In addition, similar findings are encountered by Han, Yalvac, Capraro&Capraro (2015), teachers in an urban school district, Southern USA agreed that the implementation STEM PBL in school can help students to make connection towards science and mathematics with the real world. According to Ramsey, Nemeth &Haberkorn (2013), who done a research survey regarding physics pedagogy used by physics teachers in high school, USA Midwest states, stated that urban physics teachers involved more real world - life experience in their physics pedagogy in comparison with the rural physics teachers.

V. Conclusion

The Colorado Learning Attitude about Science Survey (CLASS) – real world connection Categoryresults have reflected a strong agreement that implementation of Project-Based Learning (PBL) can increase students' real world connection towards physics. Projects came out with the questions that sometimes cannot be solved by rote learning as students engage in an active role. Moreover, projects have served to bridge classroom learning with the real-life applications. Through PBL, students have a clear understanding with the physics concepts they learned in class and indirectly can change their perception towards physics into more positive one and able to connect physics concepts into real life situations.

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