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The Effectiveness of Practical Work on Students' Motivation and Understanding towards Learning Physics

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ABSTRACT: *This study aims to determine the use of practical work in secondary school can develop students' understanding and motivation towards learning physics. A secondary school from Semporna district in Sabah, Malaysia is selected to conduct this research. A total of sixty-six (66) Form Four students (e.g., 16 years old) participated in this research.The experimental group was taught by practical work meanwhile the control group was taught by the traditional teaching method. The qualitative and quantitative data were collected via questionnaire and interviews. Pre-survey and post-surveywere administered before and after the treatment for both groups. A focus group interview was conducted in both groups to observe about their feedback. Quantitative data were gathered and analysed by usingthe Statistical Package for Social Science (SPSS) Version 22.0. Wilcoxon Signed Ranks Test showed that students in the experimental group and control group showed no significant difference in their motivation towards learning physics. However, there was a significant difference in their understanding towards learning physics after the treatment in the experimental group compared to control group. All the interviews were audio-taped and transcribed, indicated that students intheexperimental group revealedmore motivated and understood while learning physics as compared to the control group. Therefore, school teacher should conduct practical work with students frequently to increase their motivation and understanding towards learning physics.*

KEYWORDS:*physicspractical work, traditional teaching method, students' understanding, students' motivation*

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I. INTRODUCTION

In Malaysia, the physics subject is an elective subject where students pursue the subject when they are in upper secondary which is the last two years of their secondary schooling (Curriculum Development Centre, 2005). Physics curriculumtargets to produce active learners where students have the chanceto take part in the scientific investigation through hands-on activities and experimentations. Besides, one of the purposes in Malaysia physics curriculum was giving students the knowledge and skills in science and technology. Gradually, students cansolve problems and make decisions based on scientific attitudes and noble values in their everyday life (Curriculum Development Centre, 2005). Physics is a tough subject to learn (Angell, Guttersrud, Henriksen, & Isnes, 2004; Fatin, Salleh, Bilal, & Salmiza, 2012). As a result, fewer students will take up physics at school and low confidence to study the subject(Fatin et al., 2012; Lords, 2006). Based on Dolin's study (as cited in Angell et al., 2004), physicsis a subject that requires students to learn numerouskinds of representation such as experiments, graphs and mathematical symbols. Subsequently, studentsare not interested in the subject and feel boring (Hirschfeld, 2012). Many factors have contributed to the poor result of physics such as students' poor attitude and no interest towards physics (Josiah, 2013). Students think physics is boring, difficult and irrelevant to daily life (Williams, Stanisstreet, Spall, Boyes, & Dickson, 2003). Due to this matter, the enrollment of studentsinthescience stream was also becoming very low in Malaysia (Salmiza, 2014). For weaker students, they will find physics extremely dull (Yunus & Ali, 2013) and something exceedingly abstract (Lords, 2006). Theoretical knowledge is always linked to the practical knowledge which helpsstudents to develop their manipulative skills and scientific attitudes (Josiah, 2013). Students' understanding, experience, skills and enjoyment of science will also increase by having practical work.By having all these, students problem-solving skills and conceptual understanding will be enhanced (Tamir, 1991). Thus, practical work needs to be reinforced to change students' views towards learning physics. For this reason, the effects of practical work on students' interest towards learning physics are studied.

II. LITERATURE REVIEW

Practical work is defined as"…learning experience in which students interact with materials or with secondary sources of data to observe and understand the natural world"(Lunetta, Hofstein, & Clough, 2007). Students understand the science concept by having experiments in school laboratory (Bruner, 1990). Practical work can make the learning surrounding exceptional which indirectly helping the studentsto construct their knowledge, enhance logical, inquiry and psychomotor skills (Mashita, Norita, & Zurida, 2009). Furthermore, practical work createsanexperiencewherestudentscanwidenthepossibilityofconstructivist learning (Umar, Ubramaniam, & Ukherjee, 2005). Students' knowledge can be extended to understand the real worldby having practical work in a school(Millar, 2004). Besides, the teaching objectives can be achieved easily (El-rabadi, 2013). The traditional teaching approach is defined as teaching is entirely depend on textbooks where the teacher teaches the content and students sit, read, do assignments and taking notes (Ates & Eryilmaz, 2011). On top of that,students are just unresponsively receiving the information from the teachers (Liu, 2014) and without questioning the teacher (Stofflett, 1999). As a result, students could not form ideas and hard to involve themselves in discovery with building models (Ješková & Onderová, 2000). Attitudes are the ability to handle, manage the feelings and leadhuman'sbehaviour during the learning process (Kaya & Böyük, 2011). Therefore, a good practical work should be well organised and planned earlier to develop positive attitudes (Musasia, Abacha, & Biyoyo, 2012). Students who gained positive attitudes towards the subject are more likely to be found in students who used practical work in their learning (Myers & Fouts, 1992). Practical work motivates and stimulates student's interests towards mastery of concepts (Johnstone, 1997). Practical work also creates and boosts student's motivation, interest and achievement. It creates opportunities for activeteaching-learning in chemistry (Okam & Zakari, 2017). Moreover, practical work teaching method creates an environment where students can learn science seriously (Amunga, Amadalo, & Musera, 2011), takes control of the learning process (Musasia et al., 2012) and develops a better understanding of the practical work involved.

III. RESEARCH QUESTIONS

(i) Is there any significant difference on students' motivation in learning physics intheexperimental group?
(ii) Is there any significant difference on students' motivation in learning physics inthecontrol group?
(iii) Is there any significant difference on students' understandinginlearning physics in the experimental group?
(iv) Is there any significant difference on students' understandinginlearning physics in the control group?

IV. RESEARCH METHODOLOGY

A quasi-experimental design was used in this research where both groups were given sixty (60) minutes to conduct the research in six (6) weeks.Purposive sampling was employed to select one of the schools from the district. All Form Four students from three (3) science classes of the school were used as the samples for the research. Sixty-six (66) Form Four Science students (i.e., 23 males and 43 females) who took physics subject in the school were purposively selected.The stratified sampling technique was used to split up the respondents into the control group and experimental group (Gambari, Obielodan, & Kawu, 2017)wherebythirty-two (32) students (i.e., 12 males and 20 females) were appointed to the experimental group, and thirty-four (34) students (i.e., 11 males and 23 females) were inthecontrol group based on their ability levels. Before practical work is implemented, the pre-survey questionnaire was used to measure students' motivation and understanding towards learning physics for bothgroups. There were ten (10) positive statements under the category of motivation towards learning physics whereas another ten (10) with a combination of positive and negative statements of understanding towards learning physics. All the questions were adapted from (Acar Sesen & Tarhan, 2013; Glynn, Brickman, Armstrong, & Taasoobshirazi, 2011; Sze Kiong, 2010)The 5-point Likert scale was coded as 1, 2, 3, 4, and 5 according to the responses of strongly disagree, disagree, neutral, agree and strongly agree. Example statements on motivation and understanding towards learning physicsareshowninTableI and II.

Table I: Example Statements on Motivation towards Learning Physics

No.	Statements	No.	Statements
1.	I will put enough effort into learning Physics.	6.	I am confident I will do well on Physics tests.
2.	I use strategies to learn Physics well.	7.	I am confident I will do well in Physics labs and projects.
3.	I spend much time learning Physics.	8.	I believe I can master Physics knowledge and skills.
4.	I prepare well for Physics tests and labs.	9.	I believe I can earn a grade of "A" in Physics.
5.	I study hard to learn Physics.	10.	I am sure I can understand Physics.

Table II: Example Statements on Understanding in Learning Physics

No.	Statements	No.	Statements
1.	Physics symbols are unintelligible as a foreign language that I do not know.*	6.	I make many efforts to understand Physics.
2.	I can solve Physics problems easily.	7.	I find using Physics symbol to be easy.
3.	I think, learning the basic concepts are important for understanding Physics.	8.	I believe that some knowledge of Physics helps me understand the other science lesson more easily.
4.	Most of the concepts in Physics are not concrete.*	9.	I can understand Physics concepts easily.
5.	Physics is a sophisticated and impalpable lesson.*	10.	I have difficulties while using my knowledge in solving Physics problems.*

Due to students' English proficiency were low, the researcher translated all the questions into Malay Language and verified by a qualified English Teacher.For the reliability purpose, the questionnaire was piloted on thirty-eight (38) Form 4 students from other schools to assess suitability and clarity of the questions. The Cronbach's Alpha (α) Coefficient obtained was 0.888 for the category motivation towards learning physics and 0.708 for understanding in learning physicsafter reverse scoring of negative statements. Students from the experimental and control group were given the questionnaire as the post-survey after the treatment. Pre-survey and post-survey were then analysedusing SPSS Version 22.0. Wilcoxon Ranks Signed Test was then used to determine the effects of practical work on students' motivation and understanding towards learning physics. Besides, eight (8) students (i.e., four boys, four girls) were randomly selected in each experimental and control group to have an interview session. An open-ended question was adapted from Basheer, Hugerat, Kortam, & Hofstein (2017). The interview responses were transcribed, and Table III showed the open-ended question asked in the experimental and control group.

Table III: Interview Questions According to Categories for Experimental Group and Control Group

No.	Categories	Experimental Group	Control Group
i.	Motivation towards Learning Physics	How did the practical work affect your motivation to continue studying Physics in the future?	How did the traditional teaching method affect your motivation to continue studying Physics in the future?
ii.	Understanding in Learning Physics	How did the practical work affect your understanding towards Physics?	How did the traditional teaching method affect your understanding towards Physics?

V. RESULTS AND DISCUSSION

Wilcoxon signed ranks test results in Table IV showed students' motivation towards learning physics in both experimental groups have no significant difference in the median value Likert scale degree of agreement for post-survey and pre-survey. For students in the experimental group, the median value for post-survey was 4.13 and pre-survey was 4.13 whereby ($Z = 0.00$, $p = 1.00$, $p \geq 0.05$). Besides, for students in control group, the median value post-survey was 3.73 and pre-survey was 3.69 whereby ($Z = -0.49$, $p = 0.65$, $p \geq 0.05$).The data analysis showed that students' motivation towards learning physics in the experimental group did not answer the Research Question (i) and (ii) respectively. Therefore, there is no significantdifferencebetween students' motivation towards learning physics in the experimental group and control group.

Table IV: Results of Students' Motivation towards Learning Physics between Control and Experimental Groups

Group	Experimental Group (N = 32)		Control Group (N = 34)	
Likert Scale Value	Wilcoxon Signed Ranks Test		Wilcoxon Signed Ranks Test	
	Pre-survey	Post-survey	Pre-survey	Post-survey
Mean	4.10	4.13	3.73	3.65
SD	0.46	0.47	0.56	0.68
Median	4.13	4.13	3.76	3.69
Z / t -value	0.00		-0.46	
p	1.00		0.65	

***** is significant at $p \leq 0.05$

Wilcoxon signed ranks test results in Table V showed students' understanding in learning physics in experimental groups have asignificant difference in the median value Likert scale degree of agreement for post-survey and pre-survey ($Z = -2.27$, $p = 0.02$*, $p \leq 0.05$) whereby the median value for post-survey was 3.95 and pre-survey was 3.67. However, students in the control group showed no significant difference between the median value in the Likert scale degree of agreement for post-survey and pre-survey ($Z = -0.76$, $p = 0.45$, $p \geq$

0.05) whereby the mean value for post-survey was 3.68 and pre-survey was 3.60. The results from the data analysis showed that students' understanding towards learning physics in the experimental group did answer the Research Question (iii). Besides, the data analysis of students'understandingtowards learning physics in the control group did not answer the Research Question (iv). Therefore, the experimental group showed there is a significant difference on students' understandingtowards learning physics whereas the control group showed no significant difference.

Table V: Results of Students' Understanding in Learning Physics between Control and Experimental Groups

Group	**Experimental Group (N = 32)**		**Control Group (N = 34)**	
Likert Scale Value	**Wilcoxon Signed Ranks Test**		**Wilcoxon Signed Ranks Test**	
	Pre-survey	**Post-survey**	**Pre-survey**	**Post-survey**
Mean	3.66	3.88	3.53	3.57
SD	0.46	0.43	0.54	0.57
Median	3.67	3.95	3.60	3.68
Z / t -value	-2.27		-0.76	
p	0.02*		0.45	

* is significant at $p \leq 0.05$

For qualitative data, 7 emerging themes were identified from students' interview in control group which was lack of interest, lack of understanding in physics, lack of excitement, eager to have more experiments and hands-on activities, unsure of scoring 'A' in physics, lack of motivation and less confidence to answer questions as coded as C1, C2, C3,C4, C5, C6 and C7 respectively as shown in Table VI. Below are few direct quotes from students' interview:

Table VI: Interview Transcripts from the Control Group

S1 (Male)	:	"In my view, I am not confident with this traditional teaching $_{C7}$ because the students' desire to study physics will be lesser $_{C1}$ and no motivation to learn physics $_{C6}$. It is because this traditional teaching method is boring and I'm not confident to get grade 'A' on this subject $_{C5}$."
S2 (Male)	:	"For me, I have no confidence to learn physics $_{C7}$ if this traditional teaching method continues throughout the year. It needs practical work so that students are more interested in physics subject $_{C4}$. That's all."
S3 (Male)	:	"The traditional teaching methods did not motivate me to learn physics $_{C6}$. Therefore, I was less enthusiastic about learning $_{C1}$ and not confident to get 'A' $_{C5}$."
S4 (Male)	:	"To be honest, I did not understand because it's just talking and writing $_{C2}$. So, students will get bored and sleepy $_{C1}$.
S5 (Female)	:	"Traditional teaching method can influence my motivation to continue to venture intophysics field. However, I have less confidence to answer in the exam especially the experimental section in paper 3 $_{C7}$. The experiment will increase our understanding. If the teacher continues teaching like this, I do not understand what I learned $_{C2}$. So, my motivation is lacking $_{C6}$."
S6 (Female)	:	"In my opinion, I had a little understanding of physics through this traditional teaching method $_{C2}$. I felt sleepy and disliked it $_{C1}$ because the teacher just explained and gave us exercises."
S7 (Female)	:	"In my opinion, I could only understand about 30% only $_{C2}$ because there are some topics need to do a demonstration to understand the concept$_{C4}$."
S8 (Female)	:	Traditional learning will affect my motivation. I feel I'm more confident of scoring 'A' in the exam $_{C5}$. However, when I want to pursue a career in physics field, it will reduce my motivation $_{C6}$ because we are just studying in class and no activities are being done$_{C3}$.

Besides, 10 emerging themes were identified from students' interview in the experimental group which was gain more interest, understanding better in physics, gain new experience, gain excitement, physics made easy, collaboration with friends, motivated to score 'A' in physics, gain more motivation, gain confidence and able to answer physics questions and draw graphs as coded D1, D2, D3, D4, D5, D6, D7, D8, D9 and D10 respectively as shown in Table VII. Below are few direct quotes from students' interview:

Table VII: Interview transcripts from the Experimental Group

S9 (Male)	:	"Practical work affected my motivation to study physics $_{D7}$ because I can apply the physics theories when doing experiments. Besides, I am more confident to answer questions $_{D9}$ that related to the physics practical work that hasbeen done."
S10 (Male)	:	"For me, I felt that physics practical work is easy $_{D5}$. It motivated me to do practical work $_{D8}$. It was also effective where Icando the practical work and understand it $_{D2.}$"
S11 (Male)	:	"Practical work affected my understanding of physics $_{D2}$ since it involved the movement. It is because by reading the concepts, it is not enough to understand. Therefore, with practical work, we can have a better understanding. I feel satisfied with it $_{D4.}$"
S12 (Male)	:	"Practical work can influence my understanding $_{D2}$. When I do practical work, I can understand the instrument further and find out what laws are used in the experiment. Next, I can do calculations more accurately and find out how to get this value $_{D10}$. My feeling about this experiment is happy $_{D4.}$"
S13 (Female)	:	"After doing practical work, I am more motivated to study physics $_{D8}$ and wanted to venture into physics-related fields."
S14 (Female)	:	"I felt very excited $_{D4}$ after experimenting because I gained experience $_{D3}$. So, it helps me to increase my motivation to continue studying physics in depth $_{D8}$. I am very satisfiedwith the experiment. I hope it will also help to motivate myself as well as other students."
S15 (Female)	:	"I could understand the concept of inertia, acceleration, mass, and so on $_{D2}$ … uhh… I know how to draw graphs $_{D10}$ and calculate acceleration."
S16 (Female)	:	Practical work has influenced my understanding of learning physics $_{D2}$ because my friends and I have done the experiments $_{D6}$. Through the experiments, I understood the concept of physics $_{D2}$. I can write a report $_{D10}$, understand the methods and techniques of learning physics."

Generally, students from the control group gave negative views during the interview session regarding the traditional teaching method. This method did not affect their motivation and understanding towards learning physics. They were unable to understand the physics concept because most of them felt boring during the class. Furthermore, students lacked the motivation to study physics and less confidence to answer physics questions as traditional teaching method continuebeing used in teaching. Therefore, students hoped more experiments and hands-on activities to be carried out in the class. Besides, students from the experimental group able to give positive views during the interview on their perception towards the implementation of practical work. All students agreed that they gained more motivation towards learning physics. Besides, students gained better understanding in physics, gained new experience, gained excitement and able to collaborate with friends, motivated to score 'A' in physics, gain confidence and able to answer physics questions and draw graphs as after having the practical work.

Basedon Abraham'sfindings in 2009, practical work did create a short-term engagement in students' interest. However, practical work unable to motivate students especially in Year 10 which is age 14 to 15 and Year 11 which is age 15 to 16 to continue further their tertiary education or create a long-term personal interest towards the subjects.He also reported that practical work might focus more on theory and not result in motivating students to continue study in science. It can be concluded that students may prefer doing the practical work component in science rather than liking the science as a subject as suggested by Abrahams (2009). According to Mashita et al. (2009), their finding is also parallel with this study's finding where there was no significant difference on the motivation among students who did experiments. It might due to all students viewed positively to the practical or experimental experience. Students had been exposed to practical work in the lower secondary before this study and their attitude was not much affected. Thus, teachers always need to stimulate students by doing practical work to make them more understandable as described by Abrahams (2009).

Furthermore, practical work creates and boosts student's motivation which lead to effective teaching and learning in chemistry as described by Okam and Zakari (2017). According to Madeira (2009), students' interest and motivation of secondary school were increased after conducting chemistry practical work as students were not exposed to practical work before the intervention.These findings are in line with Musasia et al. (2012) stated that practical work indeed a meaningful, fun and enjoyable teaching materials to the students in schools. Students' new or refined understanding towards the subject can be developed through students' learning experience as suggested by Magnusson and Palincsar (1995). Similar findings encountered by Toplis and Allen (2012) stated in their studies that practical work helped students to understand the science content in-depth as practical work can create an environment where students learn science seriously (Amunga et al., 2011) and take control of the learning process as described by Musasia et al. (2012). According to Fogg, Carlson-Sabelli, Carlson, and Giddens (2013), students' face-to-face experimentation gives a better understanding of the

laboratory equipment operation. Practical work will eventually improve the quality of science education and students understand science concepts better though much time was spent on during experiments unlike to the traditional teaching method which involves spending lots of time to comprehend the science content as described by Kibirige and Tsamago (2013). According to Acar Sesen and Tarhan (2013) stated that student wouldappreciate the importance of learning the basic concepts for understanding the subject after laboratory activities. Students will find the symbols and concepts much easier to understand and gradually will have positive thought on the science lessons. Thus, teaching science subject by using laboratory activity based method has increased students' understanding and performance as suggested by Offei-Koranteng (2013).

VI. CONCLUSION

The results and findings revealed that if practical work can serve as a useful platform to develop positive effect on students' motivation and understanding towards learning physics. Practical work helps students in gaining more interest, new experience, excitement, had a better understanding in physics and able to collaborate with friends, motivated to score 'A' in physics, gain more motivation, gain confidence and able to answer physics questions and draw graphs as compared to traditional teaching method which did not increase students' motivation and understanding towards learning physics. Teachers should conduct practical work at least once a week to enhance students' motivation and understanding in learning physics. The Ministry of Education should give training from time to time to the teacher on the method of conducting experiments according to the module. With this, the teachers' confidence to conduct the experiments will be enhanced.

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