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TAKE-HOME-EXPERIMENT: ENHANCING STUDENTS' SCIENTIFIC ATTITUDE

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Abstract. *One classic problem in science education that is still happening today is the lack of learners' involvement in scientific activity. This may lead to not instilling positive scientific attitudes and the fostering of positive attitudes towards science is an important aspect that could promote greater interest towards science. The Take-Home-Experiment strategy is an attempt to implement an alternative strategy to ascertain whether its implementation promotes a positive attitude towards science among lower secondary school students. A quasi-experimental design was used to determine the effect of the T-H-E strategy on students' scientific attitudes. A total of 151 students in Form 2 from a lower secondary school at Pekanbaru Indonesia were divided into three groups: T-H-E group, Laboratory-Experimental group and Conventional group. The research used a questionnaire instrument on scientific attitude which consisted of 31 items with a Cronbach alpha reliability index of 0.68. The result of a one-way ANOVA shows that there was a significant difference in scientific attitude of students among these 3 groups. The mean score (mean = 3.21) for scientific attitude of the T-H-E group was higher compared to both the laboratory-experimental group (mean = 3.07) and the conventional group (mean = 2.91). This research found that the use of the Take-Home-Experiment strategy in teaching science has the potential to enhance lower secondary school students' scientific attitude.*
Keywords: *scientific approach, teaching science, scientific attitude, Take-Home-Experiment.*

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Introduction

The issue of scientific attitude is still much debated despite years of studies about it in the field of science education. This is due to its importance for the students who are learning science. Pitafi and Farooq (2012) pointed out that scientific development is dependent on continuous scientific investigation. Therefore, students' scientific attitude is important in determining their motivation and passion to do scientific research and in developing a profound interest to explore the natural phenomena in the universe.

There are two dimensions of attitude that need to be developed in learning science. The first dimension is attitude towards science. This attitude refers to the students' response after they learned science. According to Koballa and Glynn (2007), attitude towards science refers to a positive or negative emotion towards science. Meanwhile the OECD (2017) stated that attitude towards science refers to interest in science and technology, environmental awareness and valuing scientific approaches to inquiry. This means that students who are scientific literate will have a positive attitude towards science, a concern about the environment and will lead an environmentally sustainable way of life appreciating the scientific approach to inquiry. Scientific literate students (or learners) do not only focus on the inquiry process in investigating about nature, but they also focus on reading and writing science related text, as both reading and writing of science texts are important to articulate science in the form of text that produces science knowledge (Webb, 2009). Many researchers have argued for the importance of reading and writing science related investigations in order to increase scientific literacy (Yore, Pimm, & Tuan, 2007; Pearson, Moje, & Greenleaf, 2010; Webb, 2010).

The second dimension is the scientific attitude. This attitude is directly related to someone's disposition towards scientific research or activity. In other words, it is the inclination to value empirical evidence as the basis of belief on science (OECD, 2017). It also refers to the required attitude in one's effort to explore or understand natural phenomenon. According to Osman, Iksan, & Halim (2007), scientific attitude can support scientific learning and enhance the performance of scientific activity. Gokul and Malliga (2015) mentioned that scientific attitude is the most important outcome in science teaching and it is equally important as the scientific knowledge. Furthermore, they posit that in the era of science and technology, children's scientific knowledge is a necessity and as such it is important to promote positive attitudes towards science in order that children are more positive and interested towards science. Kaur (2013) also added that scientific attitude is the 'scientific spirit', which will produce an individual that is rational, objective and that can think logically.

Scientific Attitude in Science Education

According to experts, there are a few constructs in scientific attitude from the previous studies. Scientific attitude consists of wanting to know more (curiosity), to be honest and exact in recording and verify data (respect for evidence), to be open minded (willingness to change ideas), and to be able to ask critical question by means of critical thinking (critical reflection) (Harlen, 1991; Pitafi & Farooq, 2012; Kaur, 2013; Osman, Halim, & Iksan, 2003; Osman, Iksan, & Halim, 2007; Suryawati & Osman, 2018). Meanwhile Osman et al. (2007) and Pitafi and Farooq (2012) added suspended judgement and objectivity as additional constructs related to scientific attitude. Kaur (2013) and Pitafi and Farooq (2012) also included rationality as an important construct linked to scientific attitude. In addition, Pitafi and Farooq (2012) also added humility under the category of attitude that should belong to scientists.

It appears that the effective ways to promote scientific attitude among students seems to be methods or activities that involve a hands-on approach, i.e. students that are actively involved in scientific activities. Thus in teaching science, teachers must bring forward teaching methods based on the scientific inquiry approach, for example the experimental method. Ergül, Şımşeklı, Çaliş, Özdılek, Göçmençelebı and Şanli (2011) found out that students' hands-on activity in teaching based on inquiry approach promoted scientific attitude and scientific processing skill, thus contribute positively towards the academic performance, scientific literacy, and attitude towards science. Trumper (2002) also mentioned that learning science cannot be done without practical activities or field work. Meanwhile, Wahyuni, Indrawati, Sudarti, and Suana (2017) argued that science learning will be meaningful if investigation and experiment activities actively engage students and the activities are directly related to the learning resources.

It seems that many, if not the majority of science teachers, emphasize learning outcome about the knowledge aspect only. For that, the lecture method has become the main choice of instruction, because it is considered as an easy and fast way to spread scientific knowledge. Scientific attitude will be difficult to be built up with this verbalistic approach. Through this method, students are instructed to understand and memorize scientific concepts (Mallya, Mensah, Contento, Koch, & Barton, 2012; Suyana, 2011) which do not necessarily result in conceptual understanding. Furthermore, the lecture method is only considering the first two tiers of the revised Blooms' Taxonomy, which caters for the lower order thinking skills (Anderson, Krathwohl, Airasian, Cruikshank, Mayer, Pintrich, Raths, & Wittrock, 2001), whilst, the main aim of science teaching is to develop students' higher order thinking (Saido, Siraj, Nordin, & Al-Amedy, 2015).

Take-Home-Experiment (T-H-E)

There are many factors why science teachers refuse to apply the experimental method in their teaching. Previous studies showed that teachers faced some difficulties such as no science laboratory available and if the school does have one, it is shared by many classes. In addition, many science laboratories lack apparatus and materials to do experiment as well as it is time consuming (Sumintono, Ibrahim, & Fatin, 2010, Norlander-Case, Campbell, Reagan, & Case, 1998, Hazrulrizawati, 2007, Yennita, Mugi Sukmawati, & Zulirfan, 2012). Therefore, in this study the researcher designed an alternative strategy to overcome those difficulties. The Take-Home-Experiment (T-H-E) strategy is built to engage students in scientific activities and familiarize them with experiments. This strategy is expected to assist in overcoming the limitation of the absence of the science laboratory and also the time constraints. According to Zulirfan, Subahan, and Zanaton, (2013), not all levels of scientific inquiry must be learnt in the classroom or science laboratory setting, as some parts of the experiment or investigation can be performed by the students at home especially those which are not complicated and dangerous to do.

Several independent studies have inspired us in establishing the Take-Home-Experiment strategy for teaching science in lower secondary schools. Turner and Parisi, (2008) have reviewed Take-Home-Experiments for physics teaching for the first-year students on campus and distance teaching. However, this strategy is for adult learners and the size of the experiment kit used is relatively large. Zimmerman (2012) has also conducted a qualitative study of students' involvement in in-home observational inquiry activities. Meanwhile, Gendjova (2007) has con-

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ducted a study on the influence of a chemistry-home-experiment to enhance the interest of students in chemistry. Similarly, many books mentioned about scientific activities at home, especially science in the kitchen. However, studies have not yet shown explicitly how the integration of scientific activity in the classroom goes with scientific activities at home.

To apply the T-H-E strategy, the teachers or schools must prepare a Take-Home-Experiment Kit. The T-H-E kit is designed to be small and flexible, so it is easy to carry inside a school bag. Besides the kit, the students' learning module and teaching module need to be developed as a guide for the experiment carried out at home. The strategy should be thoroughly planned to include the scientific inquiry; starting from collaborative pre-investigation in class, experiment at home, and finally, the post-investigation discussion at school again. These three activities form a cycle as shown in Figure 1.

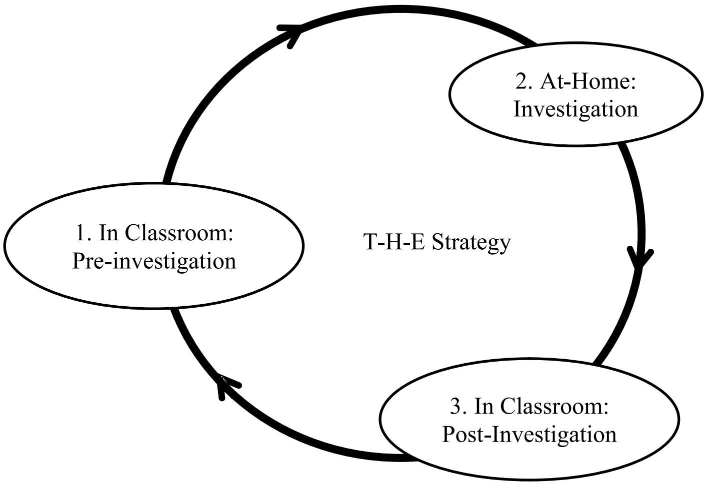

Figure 1. Inquiry cycle of the Take-Home-Experiment activity.

Scientific attitude is the most important aspect as focus during the experiment, as without a positive scientific attitude, a student tends to be only a memorizer of science concepts. In addition, a lack of a positive science attitude might also lead to a tendency to try to solve the problems of science according to the textbook, regardless of the behaviour of the natural surroundings that become the context of their science lessons. The researchers expect the Take-Home-Experiment strategy will engage students in the scientific investigation activities. This will have a positive impact on improving students' scientific skills and attitudes. Therefore, the research aimed to identify the effect of Take-Home-Experiment strategy towards scientific approach of lower secondary school students. As comparisons, the researcher used a Laboratory-Experimental method and a conventional science teaching method to examine the effectiveness of the T-H-E.

Methodology of Research

General Background

This research was conducted starting from developing the T-H-E modules of teaching and learning and the T-H-E kit. Light and optics topic was chosen in order to identify the effects of Take-Home-Experiment strategy towards enhancing scientific attitude. In these topics, the students were instructed to discover the features like propagation of light, reflection of light, refraction of light, and benefits of light in optical tools. Most of the concepts related to light and optics can be learned by the means of an experiment as an activity.

Sample

In the research, non-equivalent control group research design was used to identify the effect of the independent variable towards the dependent variable. As a preliminary study, a total of 151 students from lower secondary school in Pekanbaru, Riau in Indonesia were chosen as participants in this research. They were divided into three groups: Take-Home-Experiment (T-H-E), Laboratory-Experimental (LEM), and Conventional Science Teaching method (CST) group.

Instrument and Procedures

Non-equivalent pre-test and post-test control group design had been used to identify the effect of the independent variables on the dependent variable. The design is shown in Figure 2.

O_1	THE	O_2
O_3	LEM	O_4
O_5	CST	O_6

Figure 2. Research design.

According to Figure 2, the T-H-E group is the experimental group, whereas LEM and CST groups are the control group. Each intervention group was given the same pre-test and post-test.

In each group, students learn science in different ways. Students in the CST group learn science through the lecture method followed by an experimental method at the last meeting to verify the concept of science that had just been studied. In the conventional science teaching method, scientific experiments were done only in order to prove the science concepts explained by the teachers in previous learning sessions in class. Students in the LEM and T-H-E group learned science through inquiry approach. In the LEM group, the students do all three stages of inquiry that are the pre-investigation, investigation and post-investigation in a science learning session at the school laboratory collaboratively and under the instruction of teachers as the usual practice. When doing this scientific activity, students were given suitable activity spread sheet according to the experiment topics. The tools and materials for the experiments are those which are readily available in the science laboratory. During this method, students construct their science concepts throughout the experiment. During the T-H-E method, students do not only engage with the scientific activity in the classroom or laboratory, as some of the inquiry activities are held at home. For the pre-investigation stage of the T-H-E method, the students carry out the activity collaboratively in class under the teachers' guidance. During the investigation stage, the students do the experiment at home. The post investigation stage requires that students work in class collaboratively under the instruction and guidance by the science teachers. In order to ensure that all the three stages run smoothly, the Take-Home-Experiment kit and module of teaching and learning is required.

To collect the data, scientific attitude questionnaire for lower secondary school students was used. Although there were other available scientific attitudes instruments (SAI) (Moore & Hill, 1997; Yasar & Anagun, 2009; Pitafi & Farooq, 2012), this study used the specifically developed instrument by Zulirfan, Subahan, & Zanaton, (2015). The researcher designed this scientific attitude instrument based on eight sub constructs of scientific attitude as it is more suitable with the local context such as language and local settings. The eight sub constructs are curiosity, respect for evidence, willingness to change ideas, critical reflection, suspended judgement, objectivity, rationality, and humility. The instrument has been validated by three experts who are doctors in the field of science education and it has gone through the reliability test. The reliability test showed that this instrument has a Cronbach alpha.68. This value is considered acceptable (Chua, 2006; Nunally & Bernstein, 1994).

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Data Analysis

The participants in each group were asked to fill in the scientific attitude questionnaire before and after each intervention were carried out. Effect of the intervention was identified based on the change in mean score of pre and post scientific attitude. Descriptive analysis and one-way-ANOVA were used to identify the effect of such intervention. In this research, the researchers did not consider gender and other demographic factors. We are focusing on the effects of the Take-Home-Experiment towards students' scientific attitude in general.

Results of Research

Result of descriptive analysis on scientific attitude data for each group is shown in Table 1.

Table 1. Result of descriptive analysis on scientific attitude data.

Item	T-H-E		LEM		CST	
	Pre	Post	Pre	Post	Pre	Post
N	51	51	53	53	51	51
Mean	2.86	3.21	2.88	3.07	2.85	2.91
Standard deviation	0.29	0.25	0.24	0.26	0.22	0.21
Minimum	2.10	2.70	2.20	2.40	2.40	2.50
Maximum	3.60	3.80	3.40	3.50	3.30	3.50

Table 1 shows that the mean scores of students' scientific attitude before the intervention is quite similar, between 2.85 – 2.88. This value means the respondents had scientific attitude before intervention, although it is not satisfactory yet. The respondents' scientific attitude in each group had the same trends. After the intervention, there was an increase in the mean score of scientific data for all groups. This explains that the intervention given to each group gives positive effect towards students' scientific attitude in general.

The scientific attitude data for post intervention showed the mean score of the T-H-E group is higher than LEM group, while the mean score of the LEM group is higher than CST group. With the assumption that respondents' scientific attitude for all groups is the same before the intervention, thus based on Table 1, it can be concluded that Take-Home-Experiment gives a better effect than Laboratory-Experiment and Laboratory-Experiment method has a better effect than conventional science teaching method.

Levene's test for the score of scientific attitude before intervention has identified that the variances of the three groups were equal, $F\,(2,152) = 1.305$, $p > .05$. Due to that, a further ANOVA test was carried out to find out whether there is a difference in mean score for students' scientific attitude data before the intervention. The one-way ANOVA result test for students' scientific attitude for the three groups is shown in Table 2.

Table 2. ANOVA test result on scientific attitude before the intervention.

		Sum of Squares	*df*	Mean Square	*F*	*p*
Score for pre-scientific attitude	Between groups	0.014	2	.007	0.112	.895
	Within groups	9.563	152	.063		
	Total	9.577	154			

The ANOVA test in Table 2 showed $F\,(2,152) = 0.112$, $p > .05$ which suggested that there was no significant difference in students' scientific attitude in the three groups before intervention. This result implied that all groups had equal level of scientific attitude before the intervention. In order to know the effect of intervention given to all groups, paired sample t-test was carried out. The significant change in score of scientific attitude was obtained by comparing the pre and post score. The result of the t-test for pre and post test is explained in Table 3.

Table 3. Findings on t-test of scientific attitude before and after intervention.

Pair		Mean difference: Mean	Mean difference: Standard Deviation	*t*	*df*	*p*
Pair 1	Pre T-H-E – Post T-H-E	-.354	.358	-7.065	50	.0001
Pair 2	Pre LEM –Post LEM	-.162	.286	-4.144	52	.0001

Based on Table 3, the t-test for the mean score of the pre and post scientific attitude for each group showed that there was a significant difference in the mean score for scientific attitude between the pre and post of T-H-E group, t (50) =-7.065, p<.001 and LEM group, t (52) = -4.144, p<.001. Meanwhile, for the conventional learning group, the t-test showed that there was no significant difference between the pre and post of scientific attitude, t (50) = -1.586, p>0.05. Looking at the mean score increment, the T-H-E group (ΔM=.354) had a higher increment of scientific attitude mean score than the LEM group (ΔM=.162). Although it is not significant, students' scientific attitude in the CST group experienced a slight increase (ΔM=.053).

The one-way ANOVA test for the mean score of the post scientific attitude was used to determine the effect of independent variable, in this study it was the Take-Home-Experiment. The dependent variable in this study was scientific attitude. Before this, the Levene test had determined that the score variances of the three groups were equal, F (2,152) =1.122, p>.05. The result of the ANOVA test for the post-score of the students' scientific attitude is presented in Table 4.

Table 4. Findings on t-test of scientific attitude before and after intervention.

		Sum of squares	*df*	Mean square	*F*	*p*
Post score scientific attitude	Between groups	2.376	2	1.188	19.674	.0001
	Within groups	9.177	152	.060		
	Total	11.552	154			

The ANOVA test for the score of post scientific attitude between groups was F (2,152) =19,674, p<.001. This finding shows that there was a significant difference of the students' scientific attitude between the three groups after the intervention. Meanwhile, the post-hoc test that was carried out showed that there was a significant level of difference for post scientific attitude mean score between the three groups as presented in Table 5.

Table 5. Scheffe post hoc test difference of mean score for scientific attitude between groups after intervention.

Dependent variable	(I) Group	(J) Group	Mean difference (I-J)	Standard error	Sig. (2-tailed)
Post score scientific attitude	T-H-E	LEM	0.141	.048	.0110
		CST	0.305	.049	.0001
	LEM	T-H-E	-0.141	.048	.0110
		CST	0.164	.048	.0020
	CST	T-H-E	-0.305	.049	.0001
		LEM	-0.164	.048	.0020

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The post hoc test in Table 5 shows that students' scientific attitudes in the three groups after the intervention were different from each other. The mean score of the students' scientific attitude of the T-H-E group was higher than the other two groups. Meanwhile, the mean score of students' scientific attitude of LEM group was higher than the CST group. The difference of the mean score for the three groups differed significantly. This indicates that the interventions given to each group have had different effects on students' scientific attitudes.

Discussion

The t-test analysis showed that there was a significant increase of students' scientific attitude after the learning session was carried out, whether it is learning with utilizing the Take-Home-Experiment strategy or the Laboratory experiment method. Both learning methods provided an opportunity for students to develop their scientific attitude through scientific activities at science laboratory or at their own homes. In both strategies, the students became accustomed to the scientific activities to broaden their scientific attitude. Meanwhile in conventional science teaching, students did not receive ample time to familiarize with scientific activities, as they received more explanations from the teachers than through activities of knowing the scientific concepts.

The findings from the ANOVA and Scheffe post hoc test suggested that science learning with the Take-Home-Experiment has had a greater effect than the Laboratory experiment method in promoting positive science attitudes among students. Through the T-H-E, scientific experiments can be carried out by the students repeatedly, in their own time, at the place that is convenient for them that would make the students feel more comfortable to discover the scientific knowledge and expand their curiosity. A study by Gendjova (2007) supported this finding that students doing home experimental activities (in chemistry) showed strong interest in chemistry and their academic performance was increased, thus lead to the positive attitude towards science. Gendjova (2007) also pointed out that students in general do not face difficulties in doing the experiments but feel more confident in handling and managing their own experimental activities. The trust given by the teachers to students in carrying out experiment at home gradually will produce independent students. Therefore, in addition to enhancing scientific attitude, the T-H-E might also help to increase academic performance and at the same time grow independent young scientists.

Scientific attitude of the T-H-E group was better than other groups and this can possibly be contributed by the fact that the Take-Home-Experiment strategy tries to encourage greater participation from the students in their scientific investigation, as the greater part of the experiment was done individually by the students at home. From formulating the hypothesis to discussing the research findings, students' scientific attitude such as open mindedness, objectiveness, critical thinking, rationality and humility had successfully been developed. Hudson (2001) argued that it is important to promote student involvement in scientific research and to develop their problem solving skills (Hassan & Rahman, 2017; Syafii, & Yasin, 2013; Syukri, Soewarno, Halim & Mohtar 2018). The T-H-E strategy allowed students to be fully involved in the experiment by doing it at home. While doing the experiment, they might face some problems or difficulties. By overcoming these problems, the students slowly develop their problem solving skills.

Thomson and Bennett (2011) discovered that higher level of motivation, excitement and future orientation towards science can be found in classrooms where students report steps of interaction, hands-on activities and application in science are frequently done. These are all the elements that students indirectly experience when doing experiment at home through the T-H-E method. The greater participation in the experimental activity through the T-H-E method seems to enhance the students' motivation to learn science through conducting an experiment, thus developing students with greater scientific attitude.

The findings related to the Laboratory-Experimental method that was also used, also suggest that this method had a more positive effect than the conventional science teaching method in establishing a positive scientific attitude among students. Basically, students already have the innate feeling such as curiosity which is one of the scientific attitudes that need to be fostered. Thus, it is not a surprise that the students enjoyed scientific experiments so much. Through experiments in the laboratory, the students have had the chance to observe directly, use tools and materials, collect data and come up with a conclusion. Tobin (1990) suggested that meaningful learning is possible in the laboratory when the students are given the opportunity to manipulate the tools and materials in order that they can develop their knowledge on phenomena and scientific concepts. By discovering these concepts on their own, they feel like they are scientists. However, such attitude is not always at optimal level due to certain constrains such as lack of apparatus and time to perform experiments in the laboratory. To optimize scientific attitude, there is thus a need for direct involvement of the students in conducting experiments and this can be achieved through the implementation of the Take-Home-Experiment.

There are similarities between both the laboratory-experimental method and the Take-Home-Experiment strategy in building up students' scientific attitude. Both of these approaches stimulated curiosity by introducing to them the problem or phenomenon that need to be investigated. Their curiosity could lead them to try hard to learn new things. Curiosity is a powerful feeling as it will expose the students to new experience (Harlen, 1991). Their curiosity could spark intrigue that will lead them to ask questions (Harlen, 1991) and raise their desire to know about the thing that they are curious, thus motivate them to investigate (Pitafi & Farooq, 2012).

Before doing the experiment, students were required to formulate a hypothesis based on the given problems. Students were encouraged to try to come up with their own temporary answer towards the identified problem. In doing this, they were advised that their hypothesis does not have to be completely true and thus it must be tested through experiment. Such attitude is related to rationality and open mindedness; being open to the changes in the way of thinking based on the available evidence (Pitafi & Farooq, 2012; Harlen, 1991). Then, by doing the next step of preparing the tools and materials and conducting the experiment was the proof of their desire to find evidence rationally and not based on opinion or myth. By doing the experiments step by step, students' scientific attitudes such as curiosity, rationality, open mindedness, honesty, critical thinking and objectiveness were developed.

After conducting the experiment, students need to record the data in an observation table. This activity fosters scientific attitude related to honesty associated with data recording and verification. During the data collection, the students were trained to report data according to the finding although it did not fit the hypothesis that they made previously. Such attitude is related to the honesty in reporting data according to the observation (Harlen, 1991; Osman et al., 2007).

Based on the recorded data, students had to make inferences. Before making inference, students are trained to consider all data until a decision has been made based on evidence. In doing so, the students were encouraged to be confident in making the tentative conclusion. Osman et al. (2007), Pitafi and Farooq (2012) and other experts referred to such attitude as suspended judgement. Besides suspended judgment, the students can be trained to act objectively by conducting experiments (Pitafi & Farooq, 2012; Kaur, 2013; Osman et al., 2007). From formulating the hypothesis to discussing the research findings, students' scientific attitude such as open mindedness, objectiveness, critical thinking, rationality and humility had successfully been developed.

On the other hand, the conventional science method did not show any increase towards a positive scientific attitude. Compared to the other two strategies reported in this research project, the conventional science method required that the experimental activity was conducted at the end of the learning session with the intention to prove concepts that have been taught by the teacher(s) in earlier learning sessions. Ahmad, Osman and Halim (2010) argued that practical activity that was done at the laboratory to verify theories and carried out at an assigned level in the lesson plan did not give freedom to the students to generate and voice their own opinion. As a result, the students do not think of the experiment as a need, but only as an additional part of the teaching. Hart, et al. (2000) supported this by stating that although an experiment in the laboratory provides some benefits, there is not much mental involvement throughout the process. Therefore, conventional science teaching that places experiments at the end aimed just to prove the concept or theory, hence it does not foster curiousity in students, rather, it discourages students scientific attitude development.

Conclusions

The finding showed that lower secondary school students' scientific attitude can be enhanced through the implementation of the Take-Home-Experiment (T-H-E) strategy, as well as by utilising the laboratory experimental learning. This can be attributed to the notion that both strategies involve students' direct participation in the experimental activity to discover science concepts. The students' eagerness to discover and be familiar with scientific activities provided them with an opportunity to enhance their scientific attitude. However, if both methods are compared, the Take-Home-Experiment strategy appears to be more suitable to promote scientific attitude than the laboratory experimental method. The Take-Home-Experiment method provided more freedom for students to carry out their scientific activities. In addition, the students felt that the assigned experiment was an experiment that they could conduct themselves and hence it appears that it promoted ownership.

This study showed that scientific attitude among students of lower secondary schools in Pekanbaru, Indonesia can be strengthened through the implementation of the Take-Home-Experiment strategy. Thus, science teachers should consider this strategy as an alternative for teaching science. The government should promote this scientific enquiry learning method, as it not only seems to promote students' involvement in scientific activities, but also results in promoting a positive scientific attitude.

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In addition, the Take-Home-Experiment strategy allowed students to be involved in relatively inexpensive scientific activities. Thus, it can be used to help students and teachers in schools that do not have science laboratory or lack of science experimental equipment. Therefore, the Take-Home-Experiment strategy could help to reduce quality disparities in science education, especially for marginalized and remote schools. This strategy provided an alternative for the teacher and give ample opportunity for students from all walks of life to do experiments. This strategy is a small effort to respond to the call by Du Plessis (2018', p. 185) who firmly stated that not only "Our education should and must promote social justice", but at the same time considering alternative ways to promote science teaching, hence becoming agents of change. As such, the T-H-E strategy appears to resonate with Du Plessis' (2018) call and seems to have had a positive impact on the participants' science attitude.

References

Ahmad, C. N. C., Osman, K., & Halim, L. (2010). Hubungan ramalan persekitaran pembelajaran makmal sains dengan tahap kepuasan pelajar [Predictive relationship between sience laboratory learning environment and level of students' satisfaction]. *Jurnal Pendidikan Malaysia*, *35* (2), 19-30.

Anderson, L. W., Krathwohl, D. R., Airasian, P. W., Cruikshank, K. A., Mayer, R. E., Pintrich, P. R., Raths, J., & Wittrock, M. C. (2001). *A taxonomy for learning, teaching, and assessing: A revision of Bloom's Taxonomy of Educational Objectives (Complete edition)*. New York: Longman.

Chua, Y. P. (2006). *Kaedah and Statistik Penyelidikan, Asas Statistik Penyelidikan* [Methods and statistics research, basic research statistics]. Buku 2. Kuala Lumpur, Malaysia: McGraw-Hill Sdn. Bhd.

Du Plessis, A. (2018). Science Education in schools and at tertiary level: Status quo or embracing change? *Journal of Baltic Science Education*, *17* (2), 183-186.

Ergül, R., Şımşeklı, Y., Çaliş, S., Özdılek, Z., Göçmençelebı, Ş., & Şanli, M. (2011). The effects of inquiry-based science teaching on elementary school students 'science process skills and science attitudes. *Bulgarian Journal of Science & Education Policy (BJSEP)*, *5* (1), 48-68.

Gendjova, A. (2007). Enhancing students' interest in chemistry by home experiment. *Journal of Baltic Science Education, 6* (3), 5-15.

Gokul, R. R., & Malliga, T. (2015). A study on scientific attitude among pre-service teachers. *Research Journal of Recent Sciences*, *4*, 196-198.

Harlen, W. (1991). *The teaching of science*. London: David Fulton Publisher.

Hart, J. C, Mulhall, P., Berry, A., Loughran, J., & Gunstone, R. (2000). What is the purpose of this experiment? Or can students learn something from doing experiments? *Journal of Research in Science Teaching*, *37* (7), 655–675.

Hassan, N. M., & Rahman, S. (2017). Problem solving skills, metacognitive awareness, and mathematics achievement: A mediation model. *New Educational Review*, *49* (3), 201-212.

Hazrulrizawati A. H. (2007). *Perbandingan tahap penguasaan kemahiran proses sains and cara penglibatan pelajar dalam kaedah amali tradisional dengan kaedah makmal mikro computer* [Comparison of the level of science process skills and the methods of student's engagement in traditional practical methods with computer micro-labs] (master's thesis). Universiti Teknologi Malaysia, Johor, Malaysia.

Hodson, D. (2001). What counts as good science education? In D. Hodson (Ed.), *OISE papers in the STSE education,* Volume 2:1–21. Toronto: OISE.

Kaur, M. G. (2013). Scientific in relation to critical thinking among teachers. *Educationia Confab, 2* (8), 24-29.

Koballa, J. T. R., & Glynn, S.M. (2007). Attitudinal and motivational constructs in science learning. In S. K. Abell & N. G. Lederman (Eds.), *Handbook of research on science education*. London: Lawrence Erlbaum Associates.

Mallya, A., Mensah, F. M., Contento, I. R., Koch, P. A., & Barton, A. C. (2012). Extending science beyond the classroom door: Learning from students' experiences with the choice, control and change (C3) curriculum. *Journal of Research in Science Teaching*, *49* (2), 244–269.

Moore, R. W., & Hill, F. R. L., (1997). The scientific attitude inventory: A revision (SAI II). *Journal of Research in Science Teaching*, *34* (4), 327–336.

Norlander-Case, K. A., Campbell P., Reagan T. G., & Case C. W. (1998). The role of collaborative inquiry and reflective practice in teacher preparation. *The Professional Educator*, *21*, 1–16.

Nunally, J. C., & Bernstein, I. H. (1994). *Psychometric theory* (3rd Ed.). New York: McGraw Hill.

OECD (2017), *PISA 2015 Assessment and analytical framework: Science, reading, mathematic, financial literacy and collaborative problem solving*. Paris: OECD Publishing. doi: 10.1787/9789264281820.

Osman, K., Halim, L., & Ikhsan, Z. H. (2003). The critical thinking attitudinal profile of some Malaysian secondary students: A reflection of scientific attitudes. *Journal of Science and Mathematics Education in Southeast Asia*, *26* (2), 143-166.

Osman, K., Iksan, Z. H., & Halim, L. (2007). Sikap terhadap sains and sikap saintifik di kalangan pelajar sains [Attitudes towards science and scientific attitudes among students in science]. *Jurnal Pendidikan, 32*, 39-60.

Pearson, P. D., Moje, E. B., & Greenleaf, C. (2010). Literacy and science: Each in the service of the other. *Science*, *328*, 459-463.

Pitafi. A. I., & Farooq. M. (2012). Measurement of scientific attitude of secondary school students in Pakistan. *Academic Research International*, 2 (2), 379-392.

Saido, G. M., Siraj, S., Nordin, A. B., & Al-Amedy, O. S. (2015). Higher order thinking skills among secondary school students in science learning. *The Malaysian Online Journal of Educational Science, 3* (3), 13 – 20. Retrieved from https://files.eric.ed.gov/fulltext/EJ1085914.pdf.

Sumintono, B., Ibrahim, M. A., & Fatin, A. P. (2010). Pengajaran sains dengan praktikum laboratorium: Perspektif dari guru-guru sains SMPN di Kota Cimahi [Teaching science through laboratory practice: The perspectives of junior high school science teachers in Cimahi City]. *Jurnal Pengajaran MIPA, 15* (2), 120-127.

Suryawati, E., & Osman, K. (2018). Contextual learning: Innovative approach towards the development of students' scientific attitude and natural science performance. *Eurasia Journal of Mathematics, Science and Technology Education*, *14* (1), 61-76.

Suyana, I. (2011). Kemampuan dalam mendeskripsikan hubungan antara konsep fisika pelajar SMP dalam pembelajaran berbasis free inquiry dalam upaya meningkatkan kemampuan generik sains [Ability to describe relationship between physics concept of junior high school student in free inquiry based learning in order to improve science generic ability]. *Jurnal Pengajaran MIPA, 16* (1), 37-44.

Syafii, W., & Yasin, R. M. (2013). Problem solving skills and learning achievements through problem-based module in teaching and learning biology in high school. *Asian Social Science*, *9* (12), 220-228.

Syukri, M., Halim, L., Mohtar, L. E., & Soewarno, S. (2018). The impact of engineering design process in teaching and learning to enhance students' science problem-solving skills. *Jurnal Pendidikan IPA Indonesia*, *7* (1), 66-75.

Thomson, G. H., & Bennett, J. (2011). Science teaching and learning activities and students' engagement in science. *International Journal of Science Education, 8* (35), 1-19.

Thurstone, L. L. (1959). *The measurement of attitude: A psycho-social method and some experiments.* Chicago: University of Chicago.

Tobin, K. (1990). Research on science laboratory activities: In pursuit of better questions and answers to improve learning. *School Science and Mathematics*, *90*, 403-418.

Trumper, R. (2002). What do we expect from students' physics laboratory experiments? *Journal of Science Education and Technology*, *11* (3), 221-227.

Turner, J., & Parisi, A. (2008). A take-home physics experiment kit for on-campus and off campus students. *Journal of Teaching Science, 54* (2), 20-23.

Wahyuni, S., Indrawati, I., Sudarti, S., & Suana, W. (2017). Developing science process skills and problem solving abilities based on outdoor learning in junior high school. *Jurnal Pendidikan IPA Indonesia, 6* (1), 165-169.

Walker, J., Halliday, D., & Resnick, R. (2008). *Fundamentals of physics*. Hoboken, NJ: Wiley.

Webb, P. (2010). Science education and literacy: Imperatives for the developed and developing world. *Science*, *328* (5977), 448 - 450.

Webb, P. (2009). Towards an integrated learning strategies approach to promoting scientific literacy in the South African context. *International Journal of Environmental & Science Education, 4* (3), 313-334.

Yasar, S., & Anagun, S. S. (2009). Reliability and validity studies of the science and technology course scientific attitude scale. *Journal of Turkish Science Education, 6* (2), 43-54.

Yennita, Mugi Sukmawati., & Zulirfan. (2012). Hambatan pelaksanaan praktikum yang dihadapi guru SMP Negeri di Kota Pekanbaru [Barriers of practical implementation faced by the teachers of junior high schools in Pekanbaru]. *Jurnal Pendidikan*, *3* (1), 1-8.

Yore, L. D., Pimm, D., & Tuan, H. L. (Eds.). (2007). Language-An end and a means to mathematical literacy and scientific literacy [Special issue]. *International Journal of Science and Mathematics Education*, *5* (4), 557–769.

Zimmerman, H, T. (2012). Participating in science at home: Recognition work and learning in Biology. *Journal of Research in Science Teaching, 49* (5), 597-630.

Zulirfan, Subahan. T. M. M., & Zanaton. H. I. (2013). Early study in developing take-home physics experiment: An alternative strategy to improve science process skills and scientific attitudes. *Prosiding Seminar Serantau UKM-Unri, (6),* 1276-1286.

Zulirfan, Subahan, T. M. M., & Zanaton. H. I. (2015). The development of scientific attitudes instrument for junior high school students. *Prosiding Seminar Serantau UKM-UNRI*, (*7*), 1058-1076.

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