

Effects of Conceptual Change-Based Teaching on the Understanding of Heat and Temperature Concepts among Technical and Vocational Education and Training (TVET) Students with Different Demographic Background

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Abstract

This study endeavoured to explore the effectiveness of conceptual change-based teaching as compared to conventional science teaching on understanding of heat and temperature concepts among Technical and Vocational Education and Training (TVET) students. This study was been conducted at PERDA Advanced Technical Institute (PERDA-TECH), Nibong Tebal, Malaysia. Students' misconceptions of heat and temperature concepts was determined through relevant studies and tested through the understanding of heat and temperature concept test. This research involved 70 students from four fields of study. 35 respondents were used as control groups, and the remaining 35 were employed as experimental groups. Both groups received theoretical lessons. Only experimental group conducted experiments on the heat and temperature concepts and been exposed to the conceptual change-based teaching during the experiment. Students in both groups were tested through the understanding of heat and temperature concept test after conventional science teaching and subsequently after conceptual change-based teaching. The study was based on differences in factors of gender, areas of study, socioeconomic status and student age. All data collected, encoded and subsequently analyzed using Statistical Package for Social Science (SPSS) software. Independent sample t-tests and one-way ANOVA tests were used to determine whether there are significant differences in mean sample scores before and after treatment. The results recorded that there was a significant difference between these factors and students who were undergoing a conceptual change-based teaching understand the concepts of heat and temperature more and achieves better performance.

Keywords: Heat and temperature misconception, Conceptual Change-Based Approach, TVET Students.

Introduction

TVET has been regarded as one of the most critical drivers for the country's transformation from a middle- to high-income nation. As cited by Leong (2011), TVET plays a pivotal role in providing the skilled workforce required for the country's economic transformation. In the current Eleventh Malaysia Plan (11MP), 2016-2020 as stated in Economic Plan Unit (EPU, 2015) the focus plan is in transforming TVET to meet industry demand continued as been implemented in Tenth Malaysia Plan (10MP), 2010-2015 (EPU, 2010). In 10MP, TVET is considered as critical for supporting the country's economic development. Four policy guidelines have been put forward to mainstream and elevate access to quality TVET in Malaysia which are:

- (a) Improving the perception of TVET and attracting more trainees, through more intensive national media campaign;
- (b) Upgrading and harmonising TVET curriculum quality in line with industry requirements, by initiatives which include standardising TVET curriculum, recognising the national skills qualification, and establishing a new Malaysian Board of technologists;
- (c) Developing highly effective instructors, including to establish a new Centre for Instructor and Advanced Skills Training; and
- (d) Streamlining the delivery of TVET, including to review the current funding approach of TVET and to undertake performance ratings of TVET institutions.

Besides, in 11MP it stated that there are some initiatives taken by the government for TVET to meet industry demand which are strengthening the governance of TVET for better management, enhancing quality and delivery of TVET programmes to improve graduate employability and rebranding TVET to increase its attractiveness.

According to Maznah (2001) as cited by Esa & Abdul Rahman (2014), Technical and Vocational Education Training (TVET) has been practiced in Malaysia since the late 1890s when trade schools were considered as preparation for local youths to work as mechanics and fitters on the national railways. In 1906, a technical school was established to train technical assistants for the Railways and Public Works Department This fact proved that technical skills are very important to ensure that the country development can be achieved. However in order to become a high-income country, good academic performance without technical skills is not sufficient for graduates to become competent workers. This is the normal scenario that has been happening to today's graduates who are good with the theory courses but lack the soft-skills which are very important for their career involvement.

According to Leong (2011), currently Malaysia is embarking on various initiatives to propel the country towards its goal of becoming a high income country with developing economy by 2020. The cornerstone of this aspiration is the availability of highly skilled human capital and the lack of it could hinder the nation's endeavor to move out from the middle-income trap into a high-income economy. While Hadi, Hassan, Razzaq, & Mustafa (2015) said that this aspiration has become a paradigm shift in the world of education in Malaysia. In this context, Technical and Vocational Education Training (TVET) plays a major role to produce workers with reflexes that allow them to interact with job duties in the organization of workplace.

Other than universities, many technical institutes had been established in Malaysia. This is actually an alternative effort created by the government and personal organizations, specifically designed for the moderate and low achiever students who are unable to enter the universities. With this initiative, rather than only having the Malaysian Certificate of Education (MCE), the MCE leavers will have more opportunities to acquire knowledge and professional certificates thus increase their credibility. This will in turn enhance their opportunity for career development. Malaysian technical institutes usually offer skills programs such as manufacturing, automotive, electrical and welding. According to Md. Yunos. J, Wan Ahmad. W. M. R, Kapraw. N, & Razally. W (2006), both public institutions and private providers in Malaysia offer the Technical & Vocational Education and Training (TVET) system. There are five levels of qualifications namely Certificate, Diploma, Bachelor, Masters and Doctoral. Each level may have further division according to the nature or purpose of the qualification. Ahmad (2003) as cited by (Leong, 2011) stated that Malaysian TVET had progressively developed into three different streams namely the higher education, technical and vocational education as well as vocational skills training. (refer Table 1)

Table 1:

Main Streams of the Education and Training System in Malaysia

Stream or Pathway	Institutions	Workforce Preparation
1. Higher education	Universities and other institutions of higher learning, both public and private	Professional and managerial personnel such as engineers, architects, and surveyors.
2. Technical and vocational education	Polytechnics, technical colleges and (more recently) community colleges	Supervisory personnel such as technical assistants and supervisors.
3. Vocational skills training	Skills training institutions, public and private	Skilled and semi-skilled workers.

In Malaysian education system, elements of skills have already been applied since primary and secondary schools by introducing the subject of Life Skills (*Kemahiran Hidup*) as well as the technical and vocational education system. Then, as cited by Yunos et al. (2006), technical and vocational education programs at the upper secondary school level which was conducted by the Ministry of Education have taken a broad-based and non-terminal approach to further enhance knowledge and technical skills. The education system gives the opportunity for technical and vocational students to progress to the tertiary education level and acquire Certificate, Diploma or Bachelor's degree qualification.

TVET education will prepare graduates for semi-professional jobs such as technical assistants, service advisors and supervisors. If they further their studies to the higher level, they are qualified to hold position as a professional and managerial personnel such as engineers, architects, and surveyors. These jobs are very important in the industry as it maintain the productivity and quality of products. Besides, Hadi et al. (2015) stated that thinking skills in the form of mental activity such as careful observation, judging, inquiring, imagining, remembering, wondering, evaluating and interpreting are acquired for work

progress. Therefore, students who will be joining the workforce with TVET qualification are supposed to be equipped with thinking skills from the teaching and learning process in TVET institution. These thinking skills can be taught to the students through extraordinary course such as Physics. While learning Physics, students will develop their creativity, critical thinking and problem solving skills. Supporting this fact, Salleh, Sulaiman, Mohamad, & Sern (2017) said that, "In today's working world, industries want and expect its workers to demonstrate not only technical skills but also soft-skills like communication, critical thinking and problem solving, which are required in the workplace. Therefore, reflecting on the importance and the need to prepare higher learning institutions for workplace, soft skills have been a justifiable part for education in Malaysia".

Although the main concern of TVET institutions is to implement TVET system, the educators also emphasize the integration of soft-skill. Technical and vocational education has evolved from very basic skill training to one, which encompasses high cognitive knowledge involving the applications of mathematics and sciences (Yunos. J et al., 2006). Accordingly, Mathematics and Physics subject had been introduced to TVET students. Heat and temperature concepts is one of the main topic in Physics. During learning this topic, Physics lecturer encounter many problems in ensuring students understanding of the concepts. According to Alwan (2011), the growth of a student's conceptual framework is based on everyday life encounters and will vary according to their maturity. Nevertheless, their perception of the world around them is not in line with the statement in the scientific concept. Hence, teachers must recognize how these concepts differ from scientific explanations and why they hold these ideas. Misconceptions about the concept of heat and temperature often happen because heat and temperature exist in the form of an abstract. The idea was based on everyday activities that become the foundation of these thoughts. Practically every student possesses explanations of heat and temperature, but the findings of the most compelling research demonstrated that this statement usually is unreliable.

Instead, Lubben, Neithisaulu, & Campell (1999); Lewsis and Linn (1994) as cited by Alwan (2011) mentioned that cultural factors also perform a function in students' knowledge of heat and temperature. Therefore, it is natural for students to come to science class with a misinterpretation of the concept of heat and temperature. Since there is a significant level of student misunderstandings, conventional science teaching is not sufficient to make them realize about it (Anbazhagan & Govindarajan, 2020). Furthermore, according to Murad Demirbas (2014), in order to overcome misconceptions, it does not only require adding new information to one's cognizance but also ensuring that the synergy between fresh knowledge and present information can substitute existing knowledge. Therefore, conceptual change-based teaching approach had been tested to enhance the students' understanding in heat and temperature concept.

According to Baser (2006a), through a conceptual change-based approach, it offers a guideline to help students gain experience in mastering concepts. These guidelines provide a special learning environment such as identifying common misconceptions about heat and temperature, activating student misunderstandings by presenting simple qualitative examples, presenting descriptive evidence in the classroom that misunderstandings are incorrect, providing scientific explanations to correct situation and give students the opportunity to practice the correct description using questions. The slow development of

students in acquiring a scientific concept is due to the existence of alternative concepts in their conceptual framework on an ongoing basis.

Assimilation and accommodation, introduced by Piaget (1950) are considered necessary conditions for conceptual change. Dykstra (1992) as cited by Baser (2006a) said that assimilation is a recognition of physical or mental events adapted to an existing concept. If a concept cannot be assimilated into an existing concept, then accommodation applies. It is a change in a concept. Students must experience cognitive imbalances for accommodation to occur. If the outcome of an event does not correspond to the existing concept, this situation will cause a student imbalance with the existing concept. If students are able to assimilate the concepts presented, then no imbalances and concept changes occur. If the result of an event does not fit the student's existing conceptions, this situation disequilibrates the student with respect to his current concept. If students can assimilate the concepts presented, then there is no disequilibrium and no conceptual change. Conceptual change can be achieved by disequilibrium, which is the result of an unexpected event. Therefore, instruction should aim to disequilibrate students for conceptual change.

Research Objectives

This study was conducted to:

Test the effectiveness of conceptual change-based teaching in comparison with conventional science teaching on

Students' understanding of heat and temperature concepts.

Determine if there are any differences between genders in the post-test mean scores of heat and temperature concepts.

Determine if there are differences between the study areas in the post-test mean scores of heat and temperature concepts.

Examine whether there is a difference between socioeconomic status in the mean scores of heat and temperature concepts post-test.

Research Questions

Q1: Is there any significant difference between the mean scores of students that been taught by using conceptual change-based teaching in comparison with conventional science teaching on students' understanding of heat and temperature concepts?

Q2: Is there any significant difference between genders in the post-test mean score of heat and temperature concepts?

Q3: Is there any significant difference between the areas of study in the post-test mean score of heat and temperature concepts?

Q4: Is there any significant difference between students' socioeconomic status in the post-test mean score of heat and temperature concepts?

Hypotheses

H₀ 1: There was no significant difference between the mean scores of students being taught using conceptual change-

based teaching in comparison to the mean scores of students being taught using conventional science teaching.

H₀ 2: There was no significant difference between genders in the post-test mean score of heat and temperature concepts.

H₀ 3: There was no significant differences between the areas of study in the post-test mean score of heat and temperature concepts.

H₀ 4: There was no significant differences between students' socioeconomic status in the post-test mean score of heat and temperature concepts.

Literature Review

When one addresses conceptual transformation, the question that arises is whether the changes concept includes the replacement of a new notion with another (according to the "science"), or is it an old and new concept? Tomara, Tselfes, & Gouscos (2017) cited that, according to the preponderance belief in science domain, although teaching and learning are flourishing, the old idea is still practised in some settings. They further argued that conceptual change comprises a transformation in the status of the study concept and subsequently acquiring a higher level on scientific conception. According to Chi (2008) as cited by Goris (2010), some researchers concentrated on the process of conceptual change in terms of mind model. Besides, Lee et al. (2005) as cited by Kim, Bao, & Acar (2006) concluded that cognitive conflict encourages conceptual development. While Zohar and Aharon-Kravetsky (2005) discovered that students with high academic achievement benefit from the method of cognitive conflict teaching. In addition, Baser (2006b) concluded that cognitive conflicts encouraged conceptual changes.

As studied by Baser (2006b), Satvy and Berkovits (1980) applied cognitive conflicts in teaching strategies intended at developing children's understanding of the concept of temperature. Their verdicts indicated that training through cognitive conflict could enhance children's perception of the concept of temperature, both individually and in the classroom atmosphere. While Thomaz et al. (1995) also as cited by Baser (2006b) used a constructivist teaching approach to teach the concepts of heat and temperature at the fundamental level. The conclusions noted that this model holds the potential to advance a more solid recognition of heat and temperature phenomena Besides, Harrison, Grayson, & Treagust (1999) adopted an inquiry-based teaching model coupled with a conceptual substitution strategy to restructure alternative student ideas related to heat and temperature. They discovered that students progressively take greater responsibility for their knowledge associated to the concepts of heat and temperature, willing to take cognitive risks, and become more critical and resistant to solve both written and oral predicaments. While Ma-Naim, Bar, & Zinn (2002) as cited by Baser (2006b) used a concept-oriented approach to enhance teacher understanding of thermodynamic concepts.

Besides, to study whether factors such as gender influence the effectiveness of teaching techniques or not Veloo, Nor, & Khalid (2015) conducted a study on Attitude towards

Physics and Additional Mathematics Achievement towards Physics Achievement. The respondents consist of 203 Grade 10 students in science stream who are taking Physics as an elective subject. This research was done in secondary schools in the district of Kota Bharu, Kelantan. A questionnaire was used to gather the data regarding six aspects (24 items). The items from Prokop, Tuncer, & Chuda (2007) were translated and used to determine the students' attitude towards Physics. The findings showed a significant difference in students' interest towards Physics, career related to Physics, importance of Physics, difficulty of understanding Physics, Physics teachers and Physics equipment usage whereby the male students are higher compared to female. According to Stadler, Duit, & Benke (2000) as cited by Hazari, Sonnert, Sadler, & Shanahan (2010) found that girls think they understand a physics concept only when they can apply it to familiar real-world situations. Male students can understand the concept of physics if they can put the physics concept in the concept space that they built themselves. This situation allows male students to directly receive physics lessons delivered in the form of mathematical formulas and abstract concepts without having to work to build a relationship between physics and the real world.

Besides, for factor of different fields, the findings of Alwan (2011) who studied heat and temperature misconceptions among physics students in different fields (Physics, Chemistry, Biology, and Mathematics) in the Faculty of education Al-fateh University constructivist model was used. This study is limited to science students at the Faculty of Education, Al-fateh University. The study sample consisted of only 53 science students in major fields (Biology 24, Chemistry 9, Mathematics 13, Physics 7) and included (43 women, 10 men). Results were analyzed using the Subject Package for Social Science (SPSS) to identify students' misunderstandings of heat and temperature. The results show that most students have alternative concepts to heat and temperature. Many students are confused by the concept of heat and temperature and cannot explain the difference between heat and temperature. Furthermore, the study only involves a few factors, in other words, it is not a multi-variate study. Therefore, further research is needed to study more in depth the influence of all these independent factors and also the interaction between them.

Another study by Aziz and Alwani (2010) was conducted to study students' understanding of the concept of temperature and heat among secondary school students, especially rural school students. Instruments in the form of comprehension test questions were administered among 119 respondents who had studied this concept formally. The sample size used for this study is 119 Form 2 students from a school in Lenggong district. This number is considered sufficient to represent the study population because the acceptable sample size for a descriptive study is only 10 to 20 percent depending on the population size (Gay, 1992). The data obtained were analyzed using Statistical Package for the Social Science 13.0 for Windows (SPSS 13.0). The results show that there are differences in students' understanding of the concept of temperature and heat with the real science concept. Not all ideas used conform to scientific concepts that should be mastered. Supporting this, Veloo et al. (2015) mentioned that Physics is unpopular and known to be a boring subject among students in secondary schools especially in the rural areas. Therefore, various parties need to be sensitive and take into account the alternative frameworks and plan the teaching strategies to improve students' understanding. In addition, authentic teaching techniques must be applied in the learning centres to make the teaching and learning method more productive.

Methodology

This research was conducted to test the effectiveness of teaching techniques, which are conceptual change-based teaching and conventional science teaching on students' understanding of heat and temperature concepts. The method employed to address this misconception was to use a conceptual change strategy designed to encourage the acquisition of new concepts as a result of the exchange and difference of existing concepts and to combine innovative ideas with existing ones. This conceptual change instruction offers a set of guidelines to support students obtain experience in understanding and mastering concepts.

Research Sample

This study was conducted for approximately 3 weeks. A total of 70 students were selected as the study sample which consists of four different fields of study namely Product Design, Tool and Die Design, Machining and Agriculture. The target of the study is at a technical institute in Nibong Tebal, Penang and all these classes are taught by the same teacher. The sample was divided into two groups, namely the control group of 35 students and the experimental group of 35 students as well. They consist of 42 male students and 28 female students aged between 18 to 30 years.

Research Procedure

Conventional science teaching and conceptual-based teaching approach were been tested for its effectiveness on students' understanding of heat and temperature concepts. This study was been carried out by quasi- experimental. The control group received conventional science teaching while the experimental group received conceptual change-based teaching. Prior to treatment, both groups received traditional science lessons 2 hours a week. This conventional science teaching method uses teacher-centered teaching techniques where teachers deliver lessons and hold discussions in thermodynamic concepts regarding the module.

The difference between the two groups is that the experimental group conducts the experiment according to the situation of conceptual change, while the control group does not conduct the experiment. Since only experiments differentiate these teaching techniques, it is believed that this study can examine the effectiveness of conceptual change-based teaching on students' understanding of heat and temperature concepts. Students of the experimental group were first given a picture of the situation to raise cognitive conflict and questions in their minds. To activate students' misconceptions in determining temperature through the senses, students are given an overview of the following situations: On a rainy and cold morning, a boy washes his hands using a tap in his room. He said that the tap water was very cold. Then his brother from outside entered the house, washing his hands with the same tap water saying that the tap water was quite warm. Through this situation, students are asked to discuss whose statement is correct about the temperature of the tap water. This condition causes cognitive conflict in the minds of students in determining temperature through the sense of taste. Then students are asked to practice an experiment on "Estimating Temperature with Sense of Taste".

In these experiments students are given three beakers containing water at different temperatures i.e. 0°C (beaker A), 25°C (beaker B) and 40°C (beaker C). They were requested

to put the right hand into beaker A and left hand into beaker B. Then they tell which is “hot” and “cold”. A few minutes later, they are asked to enter a right hand that cold into beaker C and stated the water is hot. Then the hot left hand was put into beaker C and they stated the water is cold anyway. After the internship, they asked to measure the temperature of the water using the thermometer. Students will think about the determination of temperature through the sense of taste. This situation has triggered the state of conceptual change of the first stage among the students which is they feel unsatisfied with their existing conceptual understanding.

Then students are asked to estimate the temperature of the wooden and iron parts of the laboratory table by touching it. This time students say that although the iron part of the lab table feels cooler than the wooden part, to say that the iron part has a lower temperature is incorrect. This is because they have understood that the sense of taste cannot accurately determine the temperature. Then students are asked to measure the temperature for both parts. They found that both were at the same temperature. The teacher later explained that what felt through the object's touch was the energy transferred between the finger and the object was not the temperature. This explains that the temperature of the objects that are in the same place at a relatively long time is the same even if we feel that the temperature of those objects varies. This clearly describes a logical new concept to solve students' problems. This new concept can be used to explain the same conditions students will meet, for example they will understand why if sitting on a stone will feel cooler than sitting on a wooden bench.

Data Collection

This study used quasi-experimental design that involved quantitative method. In order to obtain the necessary information in this study, the instrument were used which are The Diagnostic Test for Understanding the Heat and Temperature Concepts. Student evaluation was carried out before and after treatment to see the difference in students' level of understanding through conventional science teaching and conceptual-based teaching.

Validity and Reliability

Before the instruments were administered, several procedures were used to obtain the validity and reliability of the Diagnostic Test Set to ensure that the instruments used had high validity and reliability. The validity of the item was initially obtained from an experienced lecturer in the field of Physics who can verify that the question item is relevant and in accordance with the study objectives. Upon confirmation, the reliability of the question item is tested through pilot test. Arain, Campbell, Cooper, & Lancaster (2010) proposed as cited by Lowe (2019) that a pilot study is a small feasibility study designed to test various aspects of the methods planned for a larger, more rigorous, or confirmatory investigation. The primary purpose of a pilot study is not to answer specific research questions but to prevent researchers from launching a large-scale study without adequate knowledge of the methods proposed.

For this research, pilot studies were conducted among 25 students different from the actual sample. The findings from pilot tests enabled the study planning to be re-endowed in more detail, focus, realistic and practical to be implemented (Lowe, 2019). The data was analyzed using Statistical Package for the Social Sciences (SPSS) software to test the internal consistency of the instrument using the Alpha Cronbach coefficient (Taber, 2018). The

interpretation of acceptable reliability formation according to research practitioners in social sciences is more than $\alpha=.60$. According to Taber (2018) $\alpha= 0.71 - 0.99$ is the best level that represents 71% - 99% of item reliability by sample.

Diagnostic Test

After testing the validity and reliability of the instrument, the diagnostic test is implemented, which are the Pre-Test and Post-Test administered in two different periods. Diagnostic tests are carried out among students to study their misconception on the concept of heat and temperature. Pre-test is conducted to both control group and experimental group that have undergone conventional science teaching in theoretical topics of heat and temperature. The Post-Test was conducted after the experimental group underwent a conceptual change-oriented teaching process after the practical class. Post-test was given to both groups to identify whether there was a change in students' level of understanding for experimental groups after intervention or treatment was carried out.

Here, the differences in students' mean scores in diagnostic tests are studied whether there are significant differences or not in the mean score of experimental groups compared to the mean score of control group. There are two sections in this test that require the respondent's answer, the first part consisting of 25 objective items which are optional items taken from several reference books for secondary education certificate physics (SPM) and from the source of the Alwan (2011) study article. The second part consists of a subjective question that is broken down into 4 fractions of structural questions. Subjective items require respondents to write their own answers in the spaces provided. Tested items include heat, temperature and thermodynamic topics focusing on the heat and temperature concepts.

Data Analysis Method

All data collected, encoded and subsequently analyzed using Statistical Package for Social Science (SPSS) software. Independent sample t-tests and one-way ANOVA tests are used to determine whether there are significant differences in mean scores of sample before and after treatment. Besides, the analysis is also to find out the factors that influence the effectiveness of these teaching methods such as gender, field of study and socio-economic status of the family.

Research Findings

H₀ 1: There was no significant difference between the post-test mean scores of students being taught using conceptual change-based teaching in comparison with the post-test mean scores of students being taught using conventional science teaching.

Table 1:

Mean results, the standard deviation of post-test and t-test results between control group and experimental group

	Group	N	Mean	Std. Deviation	t-test	p-value
Post-Test Score	Control	35	12.17	2.895	16.546	0.000
	Experimental	35	23.17	2.662		

the experimental group. The results showed that there was a significant difference between the post-test mean scores of the control group compared to the experimental group, which means that the experimental group's mean score exceeded the control group's mean score of 11.0. Based on the independent sample t-test results of $t = 16.546$, $df = 68$, $p = 0.00$, the p-value was less than 0.05. It symbolised that conceptual change-based teaching held more impact on the students' level of understanding than conventional teaching methods. Based on the results of Levene's test, the probability value was $p = 0.548$, and the null hypothesis was rejected as $p > 0.05$. Hence, the post-test scores of the control group and the experimental group were assumed to have similar variances in the population. It indicated that the assumptions were complied with to carry out this test.

H_02 : There were no significant differences between genders in the post-test's mean scores of heat and temperature concept.

Table 2:

Mean results, the standard deviation of post-test and t-test results by gender

* $p < 0.01$

	Gender	N	Mean	Std. Deviation	t-test value	p-
Post-Test Score	Male	43	19.26	6.226	2.837	0.006
	Female	27	15.15	5.318		

Table 2 shows mean, standard deviation and t-test results between the control group and the experimental group. Based on the results of the independent sample t-test, there was a significant difference between the mean post-test scores for male students compared to the mean of the female test scores based on the test results at $t = 2.837$, $df = 68$, $p = 0.006$. The p-value was less than 0.05. The mean difference in mean score was 4.11, whereby the mean score for male student score exceeds female student mean score. It showed that the mean of the male student score is significantly different from the mean of the female student score after the conceptual change-based teaching. According to the study of Hazari et al. (2010), male students can directly understand a physics concept without having to associate it with the real world. Based on the results of Levene's test, the probability value was $p = 0.165$, and the null hypothesis was rejected as $p > 0.05$. Accordingly, post-test achievement scores for male and female students were assumed to have similar variances in the population. It meant that hypothesis assumptions were followed to carry out this test.

H₀₃ : There were no significant differences between the study areas in the post-test's mean scores of heat and temperature concepts.

Table 3: One-way ANOVA Test Results for the Field of Study Factor

* $p < 0.01$

	Total square	Mean Square	dk	F	Sig.
Inter groups	1737.836	579.279	3	42.217	.000
In the groups	905.607	13.721	66		
Total	2643.443		69		

The one-way ANOVA test in table 3 shows that at least one pair of post-test's mean scores of heat and temperature concepts differed significantly for each field, $F(3,66) = 42.22$, $p < 0.01$, $\eta^2 = 0.66$. Impact size determined that field factors explain 66 % of the variance in post-test scores.

H₀₄ : There were no significant differences between students' socioeconomic status in the post-test's mean scores of heat and temperature concepts.

Table 4: One-way ANOVA Test Results for Family Income Factors

* $p < 0.01$

	Total Square	Mean Square	dk	F	Sig.
Intergroups	24.514	8.171	3	.206	.892
In the groups	2618.929	39.681	66		
Total	2643.443		69		

The one-way ANOVA test in table 4 shows that there was no significant difference between mean test and mean scores of heat and temperature concept test for each family income range, $F(3,66) = 0.206$, $p > 0.01$, $\eta^2 = 0.009$. Impact size explained that family income factors showed only 0.9% of the variance in post-test scores. Because there was no significant difference in post-test's mean scores, the Tukey Post Hoc test was not required to determine which family income range was higher and lower in the post-test's mean scores.

Contribution

Conceptual change-based teaching holds a considerable positive impression on many people, especially teachers and students. Through this arrangement of teaching, teachers can convey a concept more efficient and productive as well as students can quickly grasp and master it. It will enhance the culture of knowledge among teachers and students, further to enhance the quality of the teaching and learning process. Besides, teachers should also be given In-Service Training to develop teaching skills through new teaching methods. It is to produce more teachers who are skilled in teaching conceptual change-based approach.

Furthermore, this dynamic and more student-centred learning method will empower students to be more imaginative and innovative. It makes them more open-minded and can easily accept changes in a notion. Thus, as cited by McLeod (2012) the cognitive theory founded by Jean Piaget (1971) can be followed. According to this theory, knowledge is made up of mental structures that are built and rebuilt when somebody communicates with their surroundings. Each structure is a body of knowledge that will change as the individual discovers a new idea. As cited by Baser (2006a), sometimes, new ideas can be adapted to existing ones. This situation is called assimilation and accommodation where changes in the understanding of a concept occur were introduced by Jean Piaget (1952); Wadsworth (2004) as cited by McLeod (2012).

Discussion

From the research findings, overall result showed that conceptual change-based teaching held more impact on the students' level of understanding compared to conventional teaching methods which coincide with the results of some previous studies. However, when viewed in terms of gender factors, male students have better achievement in understanding Physics than female students. This fact also supported by previous study which assumed that male students can directly understand a physical concept without having to relate it to the real world. Besides, the factor of study areas also gave the different impacts in the finding. The result showed that students from different field of studies had different level of understandings in heat and temperature concepts. This finding also been supported with previous study which stated that although students came from different field of studies, they had the same problems in understanding the heat and temperature concepts. Besides, reviewed from previous study showed that factor of socioeconomic status also play the important role in students understanding of heat and temperature concepts. However, from this study, it found that students with different socioeconomic status had no significant differences in their level of understanding in heat and temperature concepts. This may be due to the teaching and learning process were given equally for all students without considering the family backgrounds or other factors.

Ergo, through this conceptual change-based teaching technique, the preponderance of students was successfully recovered from the misconceptions. It attested that this teaching technique is more productive than conventional teaching. Students will follow and comprehend a concept more easily, given more prominent expression and appreciation of a concept. Besides, students will be more enthusiastic in continuing to learn to enhance their awareness and understanding. It will create a conducive learning atmosphere where learning will be more student-centred than teacher-centred. Through this learning method, all students will present their doctrines to grasp a concept or resolve a predicament. Accordingly, an accurate concept can be effectively mastered by students.

Conclusion and Implications

From this study, the findings revealed that conceptual change-based instruction through lab experiment strategy appeared to be successful in altering students' misconceptions related to the ideas of heat and temperature concepts. This result support the social constructivist theory developed by Vygotsky. According to Schreiber and Valle (2013) as cited by Kola (2017), Vygotsky argued that learning is a social and collaborative activity where people create meaning through their interactions with one another. While students created ideas through interaction with the teacher and other students (Kola, 2017).

Besides, learning is a process of interaction through which the learners develop their understanding by assembling facts, experiences, and practices. During lab experiment, educators create dissatisfaction in student's mind with his alternative conception which was called cognitive conflict, followed by strengthening the status of the preferred scientific conception. The method of dealing with misconceptions was to use strategies of conceptual change approach to promote the acquisition of new concepts by exchange or integration of new concepts with the existing one. According to Baser (2006a), the conceptual change approach offered a set of guidelines to help students gain experience in grasping the concepts. These guidelines provided special learning environments such as identifying common misconceptions about heat and temperature, activating students' misconceptions by presenting simple qualitative examples, presenting descriptive evidence in class that the typical misconceptions are incorrect, providing a scientifically correct explanation of the situation, and giving students the opportunity to practise the correct explanation by using questions. The nature of the conceptual change approach can enable the students to progress at their own pace and to encourage students to use their thinking ability.

Furthermore, by implementing conceptual change-based approach, Piaget's Theory of Cognitive Development has also been followed. This theory stated that assimilation occurs when we modify or change new information to fit into our schemas (what we already know). It keeps the new information or experience and adds to what already exists in our minds. While accommodation occurs when we restructure or modify what we already know so that new information can fit in better (Zhiqing, 2015). In fact, it is proven that conceptual change-based approach during lab experiment as an effective method to be implemented by educators. This approach is able to diversify the strategy in teaching and learning, thereby improve the students' understanding in the science concepts, which can contribute to the improvement of the mastery of science knowledge. Marion et al. (1999) as cited by Baser (2006a) suggested that teaching for conceptual change should be the particular focus of some courses related to teaching methods and teaching practice in teacher education programs. By this effort, teachers can enhance their teaching skills to overcome students' conceptual understanding. This facilitates prospective teachers' learning to apply conceptual change-based approach effectively. Indirectly, school, institute, college or university can improve the quality in teaching and learning process. Therefore, it is recommended that the constructivist model be fully implemented for the physics learning at all level.

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