The Effectiveness of Predict-Observe-Explain-Animation (POE-A) Strategy to Overcome Students' Misconceptions about Electric Circuits Concepts

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Abstract

This study aims to determine the effectiveness of Predict-Observe-Explain-Animation (POE-A) strategy to overcome students' misconceptions about electric circuits concepts. POE-A strategy aims to trigger students' conceptual change and improve their understanding about electric circuits' concepts. This pre-experimental study involving 43 Form Four students was conducted at a secondary school in Muar, Johor. In this study, pre- and posttest designs were used to identify and compare the students' misconceptions level before and after implementation of POE-A strategy. The diagnostic test DIRECT version 1.0 was adapted as an instrument for this study to determine the students' misconceptions level about electric circuits concepts through pre- and posttest scores. Findings show that the electrical current domain recorded the highest increase of 26% through pretest and posttest comparison, followed by the physical aspect of the circuit domain and energy domain at 24% and 14% increment respectively. The voltage domain showed the least increment at only 14%. Percentage increase in posttest score indicated that students' misconceptions level declined after the intervention of POE-A strategy. Based on the findings of this study, it is arguable that the POE-A strategy can overcome students' misconceptions about electric circuits' concepts. In addition, this strategy can help students to enhance their understanding of the concepts.

Keywords: Misconception; Electric circuits; Predict-Observe-Explain-Animation (POE-A) strategy; Conceptual change

Introduction

Background and Overview

Physics can be defined as a scientific subject involving concepts such as force heat, light, gravity pressure, electric current and their interaction with matter. Physics is one of the branches of science that can be learned by students throughout schools and higher education institutions. Moreover, it is a branch of knowledge that is very important in everyday life. Early in 1967, Physics subject was introduced as Modern Physical subject for the Form Four students in science stream. The goal of the Physics curriculum is to provide knowledge and skills to students to assist them in solving Physics-related problems as well as to help the students in making informed decisions based on scientific knowledge and attitudes (Bunyamin & Finley, 2016). However, the 2018 *Sijil Pelajaran Malaysia* (SPM)- a terminal examination after five years of secondary schooling- performance report revealed that the students' performance in

Physics is a far cry from achieving its goal. The report showed a decrease in students' achievement where the grade point average (GPA) for Physics has dropped from 4.09 in 2017 to 4.27 in 2018 (EB 2018, p. 12) – note the lower the GPA value the better the performance is. The decline in SPM achievement in physics reflects that the SPM candidates face problems in applying and relating the ideas and concepts in Physics specifically in problem-solving and decision-making questions. The report also highlighted that many students were facing difficulties in answering questions related to electrical concepts that might be contributed by the lack of fundamental understanding in this concept.

Other than the previously alarming and concerning issues reported by the Malaysian Examinations Board, a study conducted by Korganci et al. (2015), Kaltakci-Gurel, Erilmaz, and McDermott (2017), and Phanphech and Tanitteerapan (2017) also draw special attention to the pertinent issue of misconceptions among students. According to these researchers, misconceptions particularly in electrical concepts occur due to the abstract nature of the electrical concept. For instance, the students are unable to observe the movement of electrical charge (electrons) leading to misunderstanding and misconceptualization of the electrical concept.

Rationale and Problem Statement

In addressing these misconceptions, many researchers have suggested the implementation of a conceptual change teaching strategy (Liu, 2004; McKenna, 2014). As claimed by Van Breukelen et al. (2015), effective teaching strategy to overcome students' misconceptions should facilitate conscious thinking which ultimately triggers a conceptual change in student's mind. According to Duit, Jung, and Rhoneck (2012), the conceptual change process is difficult to be successfully achieved through traditional teaching methods. Conceptual change can only be achieved if the students are confronted with concepts that raise conflict with their existing concepts (Posner et al., 1982). This situation will create a cognitive conflict that drives students to reflect on their existing concept while trying to resolve the conflict. In other words, this cognitive conflict will challenge the students' misconception and encourage them to build an accurate scientific concept. Therefore, teachers are responsible for developing strategies to create students' cognitive conflicts, providing questions to discover misconception, and help students to build scientific concepts. Apart from identifying the initial ideas of students, the conceptual change strategy provides an opportunity for students to voluntarily explore new ideas, modify and even change their ideas (Liu, 2004; McKenna, 2014).

Based on the critical review of previous studies, various teaching strategies focusing on the conceptual change have been proposed to address the students' misconception. For instance, analogy (Korganci et al., 2015), text conceptual change (Küçüközer & Demirci, 2008), cooperative discussions (Korganci et al., 2015), animation (Lee & Law, 2001), simulation (McKenna, 2014), concept mapping (Liu, 2004), and Predict-Observe-Explain (POE) (Kibirige, Osodo, & Tlala, 2014). This study adopts the definition of conceptual change by Posner et al. (1982) as a process that involves restructuring or replacing students' pre-existing preconception towards the accepted scientific concepts.

Research Aims and Significance of Study

Students' misconceptions cannot be ignored because they may hinder learning. Most importantly, if it is not removed or addressed, the students will carry the misconceptions forward and ultimately trigger another misconception. Based on the literature review, POE teaching strategy is recommended by many researchers as one of the most effective teaching methods in overcoming misconceptions. However, empirical study that aims to test the effectiveness of the POE strategy for the concept of electrical circuits is scarce. Therefore, the purpose of this study is to test the effectiveness of the innovative POE, namely POE-A (combination of POE and animation element) in overcoming students' misconceptions in electrical circuit concepts. This study is expected to contribute to pedagogical advancement particularly in Physics education by making Physics teaching and learning more interactive and effective in delivering the concept of abstract Physics.

Conceptual Framework

Based on constructivism theory, Piaget's cognitive development theory, Posner conceptual change model and the cognitive theory of multimedia learning, Figure 1 shows a connection between the teaching process of conceptual change and POE-A strategy.

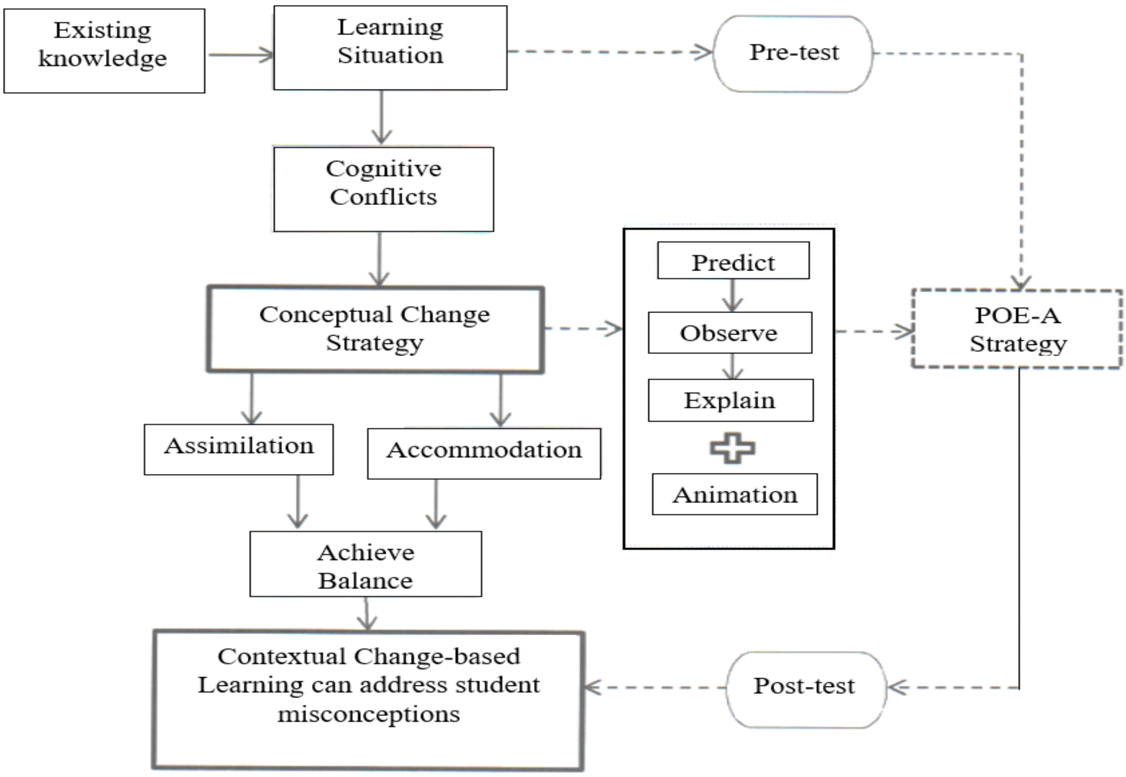


Figure 1. Conceptual Framework

Constructivism theory argues that students bring their existing knowledge based on their experience to the classroom. Acknowledging this pertinent point, the POE-A strategy emphasizes the importance of using existing student knowledge for meaningful learning processes. Through POE-A strategy, the learning process is student-centred, and teachers become the facilitator. Knowledge and experience were developed through meaningful activities planned in the four phases of POE-A strategies which aims to encourage discussion and ideas.

Next, Piaget's cognitive development theory emphasizes that learning is an active process and knowledge is organized into student minds using mental patterns or schemes. The process of connecting new knowledge with existing schemes is named as assimilation. If the new knowledge is not related to the existing scheme, then the scheme is altered or constructed - this process refers to accommodation.

In addition, this POE-A strategy also adapts Posner's conceptual change model. This model states four conditions for the conceptual change process to happen namely dissatisfaction, intelligible, plausible and fruitful. The conceptual change process can be achieved if the students are confronted with concepts that contradict with their existing concept (Posner et al., 1982). This will create a cognitive conflict that drives students to make reflection of their concept while trying to resolve the conflict. In other words, these conflicts will challenge the students' misconception and encourage them to build an accurate scientific concept.

Finally, the Mayer's (2014) cognitive theories of multimedia learning is also applied in developing POE-A strategy where animation elements are integrated. This multimedia theory emphasizes the need for active thinking and is parallel to the constructivists learning approach because multimedia materials can be associated with existing student knowledge and can be further developed to create meaningful learning experiences.

Literature Review

Electric circuit misconception

The misconception of electricity is universal where it is evident across different cultures and countries. The similarities of misconceptions throughout both cultures and countries were due to numerous external factors such as teaching methods, textbooks and the use of daily languages (Harrison, Grayson, & Treagust, 1999; Sert Çibik, 2017). The misconceptions occurred primarily due to the abstract nature of Physics concept causing students to face difficulties in conceptualizing it. In addition, teachers also have misconceptions (Acar, 2014; Acar & Bruce, 2016; Sert Çibik, 2017). According to Kaltakci-Gurel, Erilmaz. and McDermott (2017), the existence of the misconception within the student's mind greatly depends on to what extent the teacher holds the same misconception.

Critical review of previous studies on students' misconceptions on the electric current topic show that students have difficulties to understand the basic concept of the electric current (Engelhardt & Beichner, 2004; Korganci et al., 2015; Lee & Law, 2001; Maloney et al., 2001; Shipstone et al., 1988; Turgut, Gürbüz, & Turgut, 2011). These researches stated that the students were most likely to be confused between various electrical concepts such as the current, energy, and voltage. Among the most popular misconceptions is that students assume battery as a constant source of current (Anggrayni & Ermawati, 2019; Küçüközer & Kocakülah, 2007; Gaigher, 2014). The reality is that the battery is a constant source of voltage that causes the electrons to move after which produces electricity in a circuit. In addition, students are also confused between current and energy where students tend to consider that current is used by the components in a circuit such as bulbs. Their understanding is wrong because current is not used by the electrical component but energy is.

Table 1 shows frequently reported misconceptions in the literature by category. Previous studies have identified various electrical circuit misconception and categorized them into: Current Usage, Local Coronation, Voltage in a Closed Circuit, Sequential Coronation, Resistance (Duit, Jung, & Rhoneck, 1985; Gaigher, 2014; Shipstone, 1984), Overlay Coronation, Topology (Engelhardt & Beichner, 2004; Kapartzianis & Kriek, 2014), Current Clash (Osborne, 1983; Cohen et al., 1983), Agency's Battery and Basic battery (Steinberg & Wainwright, 1993; Lee & Law, 2001).

Table 1
Students' Misconceptions on the Concept of Electric Circuits

Number	Misconceptions	Description
1.	Current Usage	Current is used by components in the circuit. The student assumes that the current will decrease when it passes through bulbs.
2.	Current Clash	Current will come out of the two battery terminals, which are positive and negative, so when they clash, the bulb will illuminate.
3.	Local Coronation	Students do not assume electrical circuits as a system. They tend to focus on what happens in only one place in the circuit. For example, they have an impression that current is evenly divided when it arrives at a junction point.
4.	Voltage in a Closed Circuit	The students assume that the voltage concept has almost similar characteristics as the current concept. They tend to think of the battery as a constant current source instead of constant voltage source.
5.	Sequential Coronation	Students assume that in electrical circuits, what happens or changes before a component will affect the component, but what changes after the component does not affect the same component.
6.	Overlay Coronation	Students assume that if one battery can make the bulb glow at a certain brightness, then if two batteries are used, the brightness of the bulb will increase by double.
7.	Resistance	Resistance is considered as obstacles imposed on electric current. Students assume that resistance is the force imposed on the electrical current in the direction opposite to the flow of electric current.
8.	Basic battery	Students assume that the current is stored in the circuit. They assume that charges are pumped out of the battery and are not recycled. Plus, they often hear that the batteries need to be recharged. Then they have an initial impression that the battery is empty because the charges are exhausted.
9.	Agency's Battery	One believes that without the battery in the circuit, current will not flow.
10.	Topology	Students assume that all resistance in the series is in series whether there is a junction or not.

POE-A

In this study, the POE-A teaching strategy which focuses on students' conceptual change is used to address student misconceptions in electrical circuits. The POE-A strategy is built based on the constructivism learning theory that promotes active and interactive learning to enhance students' logical and conceptual growth (Abrahams, Homer, Sharpe, & Zhou, 2015; Wu & Tsai, 2005). Both Constructivism and POE-A strategy emphasize on student-centred learning where; 1) learning greatly depend on the classroom interaction aimed to identify the students' previous knowledge in constructing new knowledge, 2) interaction with the environment stimulates an active and conscious thought, 3) students are encouraged to talk and revisit their existing knowledge in order to construct understanding about the new concept, and 4) students are the core in learning process and educators act as facilitators (Akpan & Beard, 2016). Historically, this strategy was first introduced by White and Gunstone (1992) consisting of three phases namely P-predict, O-observe and E-explain.

POE strategy has been widely used in science education in high school level as one of the effective teaching tool to explore existing student knowledge and improve student conceptual knowledge and foremost is to address the misconceptions (Chen et al., 2018; Costu, Ayas, & Niaz, 2012; Khunsawat et al., 2015; Kibirige et al., 2014; Mamlok-naaman & Karamustafaoğlu, 2015; Sani & Sinaga, 2012; Yin et al., 2008). The POE strategy considers the existing knowledge of students and gives them the opportunity to make reflections on their existing knowledge based on the newly introduced knowledge. This act may lead students either to apply for an accommodation process or assimilation process. Furthermore, the POE strategy emphasizes on student-centred learning rather than teachers teaching in promoting meaningful learning. Therefore, students will take charge of the learning where they will follow the inquiry approach by writing their prediction. Then, they will conduct an experiment and critically reflect their prediction based on the results of the experiment. If the outcome of the experiment goes against student prediction, it will spark cognitive conflict and the reorganization of the concept may occur.

Realizing the potential of POE to overcome the student misconceptions, this study purposefully integrates the A-animation element to help students to visualize the abstract nature of the electrical concepts. The potential of animation in enhancing students' understanding of abstract scientific concepts are well documented by many researchers (Frailich, Kesner, & Hofstein, 2009; Chen et al., 2018). According to Frailich, Kesner, and Hofstein (2009) animation refers to an act or process to make something look alive, thus in this study, animation used is related to the movement of electrons within the electrical as well as the visualization of voltage, current and energy.

The advantage of computer animation compared to other multimedia elements is its ability to deliver a clear and dynamic summary of information to students (Mayer, 2014). Moreover, computer animation is very effective to describe concepts that abstract, attract attention, increase interest and motivation, (Wu & Tsai, 2005).

Implementation of POE-A Strategy

- **P**redict phase

  Students were required to express their prediction by assigning reasons on the predicted prediction. This was done individually. After that they had to discuss and achieve their group's consents on individual prediction. For example, in the concept of electrical circuits, students were asked to predict whether there was a difference in the brightness of bulbs in the series circuit and in parallel and give reasons to their prediction.

- **O**bserve phase

  Students were required to conduct an experiment and sufficient time was allocated for observation. To engage in the observation phase, they had to write their observations on their worksheet individually. This would help them to accept or reject their prediction. For example, they made a circuit connection in two forms of circuits i.e., in series and in parallel and observed the brightness of bulbs in both circuits.

- **E**xplain phase

  Students were given enough time to explain their observations and write their explanations on the worksheet. This would help them to see the differences between their prediction and observations. Finally, they discussed their ideas based on their observations so that they obtained a deeper picture.

- **A**nimation phase

  After all the three phases ended, teachers were required to explain the scientific statements on the activities done. This information was assisted by animated videos to enable students to visualize the concept of electric circuit which was abstract. In addition, students could compare among their existing concepts with the new scientific concepts, thus providing opportunities for students to reorganize their ideas.

Methodology

Research Design

Quasi-experimental design of one group pretest–posttest was used to test the effectiveness of POE-A strategy intervention. This study follows four steps; (a) create the experimental group (b) conduct a pretest to all research participants, (c) conduct the POE-A teaching strategy, and (d) conduct a posttest to all research participants. This study was conducted within two (2) weeks.

Sampling Technique

The sample of this study was Form 4 students from one of the public secondary schools in the district of Muar. There were three (3) science stream Form 4 classes at the time of the study. A total of 43 students were randomly chosen from all the three classes.

Instrument

Determining and Interpreting Resistive Electric Circuits Concepts Test (DIRECT) version 1.0 was adapted as the instrument for this study to evaluate the knowledge of secondary school students about the concept of electric circuit. In this study, the adapted version of DIRECT 1.0 compromising of 22 questions (based on four (4) domains) was used to measure students' conceptual knowledge about the concept of electrical circuits before and after the POE-A strategy was conducted. The adapted version of DIRECT 1.0 was designed to test the knowledge of students in four domains namely; (1) physical aspects of the DC electrical circuit – consist of 6 items; (2) energy – consist of 4 items; (3) current – consist of 4 items; and (4) voltage – consist of 8 items. Each question had one correct answer and the wrong answer option referred to the misconception of students. Each correct answer was given one point, thus the amount of student score for this instrument started from 0 to 22. The adapted DIRECT 1.0 instrument was piloted and the Kuder-Richardson (KR-20) formula was used to assess the reliability of this instrument. Based on the analysis of the KR-20, the value for this adapted DIRECT 1.0 instrument was .72. Therefore, it can be concluded that this instrument had an appropriate internal consistency degree.

Implementation of the study

The pretest was conducted prior to the implementation of the POE-A intervention. This intervention was conducted during a 5-day Physics study period. During this intervention period, researchers used POE-A strategy to enhance students' understanding and to overcome their misconceptions about the concept of electrical circuits. The data obtained from the study was based on pretest and posttest using DIRECT diagnostic tests before and after intervention was conducted.

Data Analysis

To determine the effectiveness of the POE-A intervention strategy, each of the diagnostic items in the instrument was analysed. This descriptive analysis aims to identify specifically the pre conceptions that were effectively affected by the intervention.

Findings and Discussions

A comparison of pretest and posttest scores was conducted to determine the effectiveness of the POE-A strategy conducted. The findings of the students' conceptual knowledge are discussed in four domains as summarised in Table 2, namely: (1) Physical aspect of the DC electric circuit; (2) Energy; (3) Current and (4) Voltage.

Table 2
Percentage of Correct Answer Based on Domain

Domain	Item number	Percentage of correct answer (%)		
		Pretest	Posttest	Increment
Current	1, 8, 9, 13	21	47	26
Physical aspect of the circuit	4, 5, 14, 16, 17, 21	29	53	24
Energy	2, 3, 10, 15	48	67	19
Voltage	6, 7, 11, 12, 18, 19, 20, 22	41	55	14

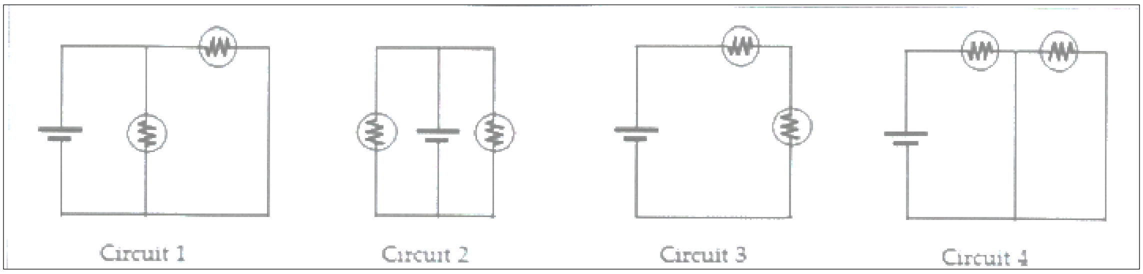
In this analysis, the question items will be discussed in accordance with the score division to the 3 score group of right answer items which is less than 30%, ranging from 30% to 70% and over 70%. The purpose of this division is to identify a frequent misconception. Item score of less than 30% refers to low conceptual knowledge level or high misconception. The item score between 30% and 70% refers to a modest conceptual knowledge level or a moderate misconception. Item scores exceed 80% refers to the highest conceptual knowledge level or low misconception.

Based on the score of the three (3) predefined item groups, it is clear that in the early stages of the study (before POE-A intervention was implemented), students have a low score indicating their conceptual knowledge level is low and the misconception is high. Students' achievement in the current domain was the lowest which was 21% in pretest and 47% in posttest as compared to the other domains. This shows that the majority of the students have a low level of understanding in the current domain. However, the current domain recorded the highest increase of 26% through pretest and posttest comparison.

i. Physical aspect of the DC electrical circuit domain

There are six (6) items used to test the conceptual knowledge of students in the physical aspect domain of electrical circuits i.e., Item 4, item 5, item 14, item 16, item 17 and item 21. Overall, there is an increase in the posttest score in all available items in the physical aspect of the DC electrical circuit domain. However, item 4 and item 17 earned a score of less than 30% in pretest as well as posttest. Item 4 gets the lowest score of 2.3% while item 17 is 18.6% in the pretest. This shows the conceptual knowledge level is low and the misconception is high in that item.

Item 4



Item Question #4		Answer Option	% Pretest	% Posttest
Which of the circuits below represent the circuits that consist of two light bulbs that are parallel to the battery?	**A.**	Circuit 1	2.3	2.3
	B.	Circuit 2	20.9	37.2
	C.	Circuit 3	16.3	14.0
	D.	Circuit 1 and 2*	2.3	20.9
	E.	Circuit 1,2 and 4**	58.1	25.6

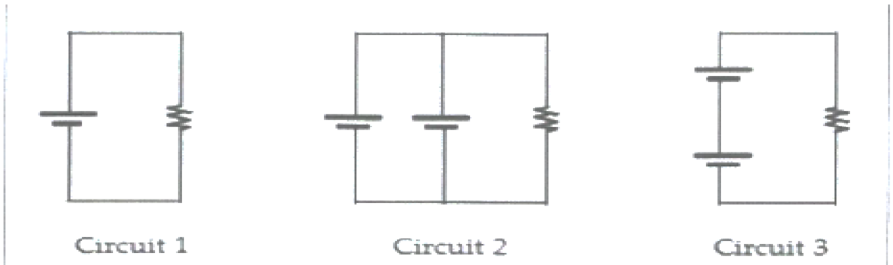
Note: (*): Correct answer; (**): Misconception of physical aspect of the circuit

Item 4 tests the student's ability to interpret schematic circuits that involve parallel circuits. Majority of the students selected E as the response of 58.1% in pretest and only 2.3% students chose the correct answer which is D. Based on E answer, circuits 1 and circuits 2 have two bulbs that are parallel to the battery while circuit 4 have two bulbs that are in series with the battery. Therefore, circuit 4 was not counted as a response to this question. However, majority of the students consider that circuit 4 is in parallel to the battery. This shows that students have a problem to interpret the schematic circuits in parallel and series forms. Even after the intervention of the POE-A strategy carried out, the correct percentage of response in posttest is only 20.9% and is still in the score group of high misconception.

i. Energy domain

There are four (4) items used to test the conceptual knowledge of students in the energy domain i.e., Item 2, item 3, item 10 and item 15. Item 10 shows a drastic increase seen from the high misconception score in the pretest which is 7% to a moderate misconception score in the post-exam of 60.5%

Item 10



Item Question #10		Answer Option	% Pretest	% Posttest
By considering the power sent to each of the resistors shown in the above circuit. Which circuits have the LEAST sent power to it?	**A.**	Circuit 1**	62.8	16.3
	B.	Circuit 2	14.0	18.6
	C.	Circuit 3	16.3	2.3
	D.	Circuit 1 = Circuit 2*	7.0	60.5
	E.	Circuit 1 = Circuit 3	0.0	2.3

Note: (*): Correct answer; (**): Energy misconception

Item 10 tests the understanding of students in the energy domain in various circuits. In the pretest, only 7% of the students chose the correct answer which is D while almost 62.8% of the students chose A. This shows that the majority of students have a misconception where they consider the use of two batteries would increase the voltage by double. In fact, in circuit 2, the two batteries were connected in parallel and thus, supply equal amount of voltage as circuit 1. Whereas, the battery in the circuit 3 is connected in series and will double the voltage. In the posttest, the majority of students can answer correctly at 60.5%.

ii. Current domain

Four (4) items were used to test the conceptual knowledge of students in the current domain i.e., Item 1, item 8, item 9 and item 13. There is an increase in the posttest scores in all items in the current domain. However, item 1 earned a score of less than 30% in the pretest which was 14%. This demonstrates a low conceptual knowledge level and a high misconception in that item. In the posttest, item 1 acquired a score between 30% and 70% indicating the modest conceptual knowledge level and moderate misconception of 53.5%.

Item Question #1		Answer Option	% Pretest	% Posttest
Is charge being used to light up the bulb?	**A.**	Yes, charges are used. The charges move through the filament producing friction that heats up the filament and generates light.**	60.5	23.3
	B.	Yes, charges are used. Charges are emitted as photons and disappear.	2.3	0.0
	C.	Yes, charges are used. Charges are absorbed by the filament and disappear.	14.0	0.0
	D.	Yes, charges are used. Charges are absorbed by the filament and disappear.	9.3	23.3
	E.	No, charges are eternal. Charges move through the filament producing friction that heats the filament and produces light. *	14.0	53.5

Note: (*): Correct Answer; (**): Current usage misconception

Item 1 tests the knowledge of students in the microscopic aspect of the current flow in the circuit. In pretest, only 14% of students responded correctly and increased drastically by 53.5% in posttest by selecting E as the answer. In pretest 60.5% students choose A as the answer showing that majority of the students have a misconception in current usage. The current usage misconception means that the student assumes charge is used by the components in the circuit and the charge will be reduced when it passes through bulbs. According to scientific concept, charges will not use up and are eternal. Charges that move through filaments produce friction that heats up the filament and produces light. The findings of this study are in line with the findings of the previous study which also reported the misconception in current usage is the most frequently encountered misconception (Engelhardt & Beinchner, 2004; Turgut et al., 2011).

iii. Voltage domain (Potential difference)

There are eight (8) items used to test the conceptual knowledge of students in the voltage domain (potential difference) i.e., Item 6, item 7, item 11, item 12, item 18, item 19, item 20 and item 22. Again, there is an increase in score for all items in the voltage domain except for item 19, there is a decrease of 84.4% to 76%. However, item 19 has a low misconception score. In the post-exam, item 18 remained with a high misconception score of 25.6%.

Item 18

Item Question #18		Answer Option	% Pretest	% Posttest
If you double the current flow that flows through the battery twice, will the voltage that goes over the battery doubles?	**A.**	Yes, because Ohm's Law is V=IR**	37.2	27.9
	B.	Yes, because if you increase the resistance, you will increase the voltage.	20.9	27.9
	C.	No, because when you double the current twice, you will cut the voltage by half.	23.3	16.3
	D.	No, because voltage is a feature for the battery*	11.6	25.6
	E.	No, because voltage is a feature for all components in the circuit	7.0	0.0

Note: (*): Correct Answer; (**): Voltage in a closed circuit misconception

Item 18 tests students' understanding of voltage and current concepts across batteries. Majority of the students answered A which is 37.2% and only 11.6% of students were able to answer correctly. Students choose A response based on their existing knowledge of Ohm's Law where if current is increased then the voltage also rises. However, this misconception is difficult to change. Even after teaching, the student still assumes that the voltage concept has a feature that is almost similar to the current concept. They tend to think of the battery as a constant current source instead of constant voltage source. This misconception is named as a voltage in a closed circuit misconception. After a POE-A strategy is conducted, there is an increase in score of the posttest by 25.6% but still in the high misconception level.

Conclusion

This study has expanded the body of knowledge on teaching strategies for physics learning where the results show that the POE-A strategy has effectively improved students' understanding of electrical circuits. Upon the intervention of a POE-A teaching strategy, students earned higher scores in the posttest in all electrical circuit domains. The electrical current domain recorded the highest increase of 26% through pretest and posttest comparison, followed by the physical aspect of the circuit domain and energy domain at 24% and 14% increment respectively. The least increment was shown by the voltage domain at only 14%. Recognizing the underlying potential of the POE-A, this study encourages educators to examine students' preconceptions and prior knowledge upon implementing POE-A strategy. It can be argued that animation was able to demonstrate the electrical current concept well but less on the other abstract concepts especially the concept of voltage. Thus, future study should address overcoming abstract by combining animation with the current technology such as Augmented Reality. Finally, this study concludes that abstract concepts like electricity should be presented as concrete as possible so as to avoid misconceptions. Hence, various teaching strategies should be taken into consideration by integrating technology to support the learning process.

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