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Reconstructing Students' Lorentz's Force Conceptions By Poe Tasks: Is It Effective?

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ABSTRACT – Students' conceptions regarding Lorentz's force do not always fit scientific conceptions after learning in class. Alternative learning that can be done is supported by relevant tasks. Therefore, this research aims to describe the development and effectiveness of POE (Predict-Observe-Explain) Tasks in reconstructing students' conceptions of Lorentz Forces on straight wires. The 3D+1I (Defining, Designing, Developing, and Implementing) research design was used in this research. In the development stage, researchers added practical activities on Observe (O) step, namely using LoFoPaT (Lorentz Force Practicum Tools). The implementation stage was given to 20 high school students (9 boys and 11 girls, with an average age of 17 years) at one of the schools in Tuban, East Java, Indonesia. After being tested using the Four-Tier Instrument on Lorentz's Force (FILOF) for the pre-post test, the results obtained were an N-Change value of 0.73 in the "High Effect" category. Most of the changes occurred in the Acceptable Change category from No Understanding (NU), Misconceptions (MC), Partial Negative (PN) to Sound Understanding (SU) or Partial Positive (PP). Eventually, this research can conclude that the POE Tasks were successfully developed and can be used to reconstruct students' conceptions into scientific conceptions based on Lorentz's force concepts.

Keywords: Student Conception, Misconception, POE Tasks, Lorentz Force Concepts

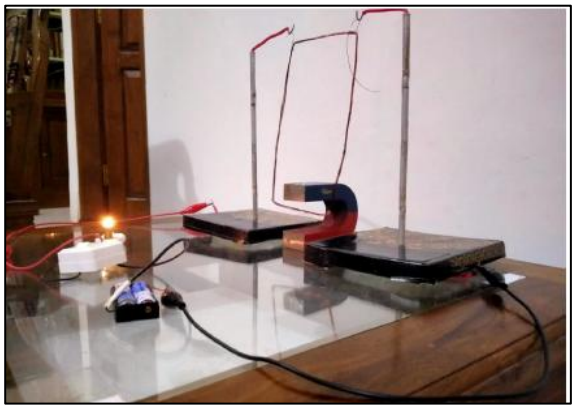
ABSTRAK – Merekonstruksi Konsepsi Gaya Lorentz Siswa dengan POE Tasks: Apakah Efektif? *Konsepsi siswa terkait gaya Lorentz tidak selalu sesuai konsepsi ilmiah setelah mendapat pembelajaran di kelas. Alternatif pembelajaran yang dapat dilakukan adalah didukung oleh tugas-tugas yang relevan. Oleh karena itu, tujuan penelitian ini adalah mendeskripsikan pengembangan dan efektivitas POE Tasks dalam merekonstruksi konsepsi gaya Lorentz siswa pada kawat lurus. Desain penelitian 3D+1I (Defining, Designing, Developing, and Implementing) digunakan dalam penelitian ini. Dalam tahap pengembangannya, peneliti menambahkan aktivitas praktikum menggunakan LoFoPaT (Lorentz Force Practicum Tools) pada tahap Observe (O). Tahap implementasi diberikan pada partisipan penelitian yang meliputi 20 siswa SMA (9 laki-laki dan 11 perempuan, yang usianya rata-rata 17 tahun) di salah satu sekolah Tuban, Jawa Timur, Indonesia. Setelah siswa diuji menggunakan Four-Tier Instrumen on Lorentz Force (FILOF) untuk pre-post test, sebagai hasilnya diperoleh nilai N-Change sebesar 0,73 dengan kategori "Efek Tinggi". Sebagian besar terjadi perubahan kategori Accaptable Change dari keadaan No Understanding (NU), Misconceptions (MC), Partial Negatif (PN) menjadi Sound Understanding (SU) atau Partial Positive (PP). Akhirnya, penelitian ini dapat disimpulkan bahwa POE Tasks berhasil dikembangkan dan dapat digunakan untuk merekonstruksi konsepsi siswa menjadi konsepsi ilmiah pada konsep gaya Lorentz.*

Kata Kunci: *Konsepsi, Miskonsepsi, POE Tasks, Konsep Gaya Lorentz*

INTRODUCTION

Conception is students' understanding of certain concepts, where conception is an essential concept for students (Cepni, Ulger, & Ormanci, 2017; Kaniawati, et al., 2019). Students' conceptions that are construct in their minds come from their experiences in learning at school or daily activities (Gurel et al., 2015). Because they have different experiences, students may have concepts that can be true or false from scientific concepts (Kaniawati, et al., 2019). For example, students are asked to explain several mathematics and science phenomena, but these conceptions are different from the concepts acquainted previously (Samsudin, et al., 2021a). For this rationale, several researchers have developed several conceptual categories in detail, namely Sound Understanding (SU), Partial Positive (PP), Partial Negative (PN), No Understanding (NU), Misconception (MC), and No Coding (NC) (e.g. Mufida, et al., 2024; Mufida, et al., 2022; Aminudin, et al., 2019; Amalia, et al., 2019; dan Costu, 2008). Nevertheless, the issue is that students have conceptions in the Partial Negative (PN), No Understanding (NU), Misconception (MC), and No Coding (NC) categories after learning in class. This can influence students' perspective for the next stage of learning (Samsudin, et. al., 2021b; Alanazi, 2020). Therefore, various situations where students' conceptions are incomplete or have misconceptions require further learning activities aimed at reconstructing students' conceptions.

Figure 1. The Lorentz Force Phenomenon based on experiments with Lorentz Force Practicum Tools (LoFoPaT)



In reconstructing students' conceptions of physics concepts, special measures are needed, especially for the Lorentz force concept at the high school level. Based on initial analyses, students experienced difficulty in determining the

direction of the Lorentz Force (Fatmaryanti, et al., 2017; Fatmaryanti, et al., 2018; Shubha, & Meera, 2019). Even research by Mufida, Samsudin, & Rusdiana (2024) found that students experienced misconceptions regarding this concept after learning in class, even though students should have an understanding of concepts in the Sound Understanding (SU) category. For example, in Figure 1, students state that the emergence of the Lorentz Force is caused by the attractive force of a magnet.

If we examine and understand the concept of Lorentz's Force, it is not as simple as writing equation 1 which only states the equation in the form of a scalar quantity, while the complete writing is equation 2 which states the equation is a vector quantity.

$$\mathbf{F_l} = \mathbf{B}.\mathrm{I}.\mathbf{L} \qquad \text{Equation (1)}$$

$$\mathbf{F_l} = \mathrm{I}\mathbf{L} \times \mathbf{B} \qquad \text{Equation (2)}$$

Sumber: Halliday, Resnick, & Walker (2013).

Most students make mistakes because they only emphasize mathematical equations, but ignore the meaning of mathematical equations into the essential concepts of physics itself. In accordance with Fatmaryanti, et al. (2017) found that many students' mistakes in determining the direction of the Lorentz force were because students did not follow the concept of vector multiplication (Fatmaryanti, et al., 2017). Directional errors also occur in understanding field direction, magnetic poles, and vector cross-products (Kustusch, 2016; Saarelainen, Laaksonen, & Hirvonen, 2007). This is a simple problem but very urgent in the context of understanding the Lorentz Force concept on a straight wire so it needs to be resolved and studied in this research.

An alternative solution to be able to reconstruct students' conceptions is to carry out learning activities accompanied by relevant and appropriate tasks. Tasks developed by teachers require special learning activities to change conceptions thereby putting students in a state of cognitive conflict (Zhao, He, Liu, & Hong, 2021; Nasri, 2020; Muliyani, 20018; Potvin, Sauriol, & Riopel, 2015; Lee & Yi, 2013). According to Posner, et al. (1982), activities in changing students' conceptions need to involve four conditions, namely a) students must feel dissatisfied with the existing concept (dissatisfaction), b) the new conception must be able to be understood (clarity), c) The new conception must make sense (plausibility), and d) The new conception must be useful (fruitfulness). According to several literature reviews, one of the

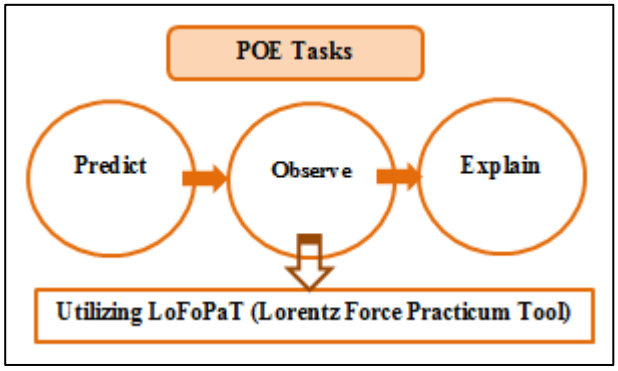
effective covering these four conditions is learning through Predict-Observe-Explain (POE) Tasks (e.g. Samsudin, et al., 2021b; Furqani, Feranie, & Winarno, 2018; Khunsawat, et al., 2015; Kirige, Osodo, Tlala, 2014; Costu, Ayas, & Niaz, 2012; Keleş & Demirel, 2010). Therefore, researchers carried the initiative to develop the POE Task in reconstructing students' conceptions of Lorentz's Force.

POE steps require students to carry out three steps in a specific task. First, students must predict the outcome of phenomena (P: Predict), where students estimate the answer to the problem given and write down the reasons. The aim is to reveal students' conceptions of phenomena (Samsudin, et al., 2021b). Second, students write down what they see and what happens (O: Observe). At this step, students carry out independent observations through simple practicums (Chen, 2022; Samsudin, et al., 2017). Finally, students explain the results of their observations on a worksheet, which will help them see the difference between predictions and observations (E: Explain) (Nasri, 2020). All of these activities can reconstruct students' conceptions into Sound Understanding (SU).

Several researchers previously implemented POE Tasks in physics learning, e.g. Furqani, Feranie, & Winarno (2018) for learning the concept of vibrations and waves, Nasri (2020) applies the POE method to overcome students' misconceptions about electrical circuits, Samsudin et al. (2021) developed POE assisted by Rebuttal Text regarding the concept of Newton's Law, Purwanto, et al. (2019) increased students' understanding of electrostatic concepts through POE-based demonstration techniques, and Keleş & Demirel (2010) corrected misconceptions related to the topic of color issues in light. However, there is only a little POE Tasks research to reconstruct students' conceptions about Lorentz's Force topic on a straight wire.

Appropriate of previous literature research, researchers aim to reconstruct students' Lorentz's Force conceptions by POE Tasks. In supporting the intelligible, plausible, and fruitfulness conditions of Posner, et al. (1982) in POE Tasks, this research adds practical activities at stage O (Observe). Practical activities used Lorentz Force Practicum Tools (LOFoPaT) which have been previously developed by Mufida, Samsudin, Rusdiana (2024). Therefore the learning flow and content for using POE Tasks in this research is shown in Figure 2. Practical activities require students to perform their hands-on skills.

Figure 2. Steps and content of POE Tasks for the Lorentz's force topic



As regards the previous explanation, this research aims to present the results of the development and effectiveness of POE tasks specifically for reconstructing high school students' conceptions of Lorentz's forces on wires. The implementation of the structured steps of POE Tasks is expected to be able to reconstruct students' conceptions into Sound Understanding (SU) conception categories and have a correct understanding of concepts according to scientists' conceptions. Thus, learning physics indicates meaningful learning, especially learning the topic of Lorentz's force on a straight wire.

LITERATURE REVIEW

Predict-Observe-Explain (POE) Tasks

The initial emergence of POE Tasks began with a learning strategy that was first proposed by White and Gunstone in 1992, which was constructivist learning (Yurttas-Kumlu & Sahin, 2022; Costu, Ayas, & Niaz, 2012; Kearney, et al., 2001). POE is an efficient strategy for eliciting student ideas and encouraging students to discuss their ideas (Abdullah, Nayan, & Hussin, 2017; Kearney & Treagust, 2000; Akpınar, 2013). In addition, POE activities include social constructivist learning, meaning that learning is a social activity where students are involved in building the meaning of concepts through discussion (Kearney, 2004).

The POE strategy is based on the classical model by generating initial predictions, discussing predictions, observing activities to test predictions in the form of asking questions, collecting data, and analyzing and concluding observation results (Samsudin, et al. 2019; Ayvacı, 2013). POE activities begin with making predictions, testing predictions, and correcting initial guesses to obtain valid explanations (Zhao, et al., 2021; Berek, Sutopo, & Munzil, 2016). At the end of the activity, explain the contradiction between

initial predictions and the results of observations that have been made (Wang, 2024; Kearney & Treagust, 2000). Systematic POE steps can be used to change students' conceptions.

To improve conceptions, the POE step has been used to investigate students' thinking ideas (Harman & Yenikalayci, 2022; Hsu, Tsai, & Liang, 2011; Liew, 2004; Kearney, et al., 2001; Palmer, 1995). Through various kinds of student ideas, many researchers apply POE steps to stages on worksheets or assignments. Therefore, several research findings on POE can be used to change conceptions and reconstruct students' conceptions (e.g. Radovanovic & Slisko, 2013; Samsudin, et al., 2017; Samsudin, et al., 2021; Abdullah, Nayan, & Hussin, 2017; Coştu, Ayas, & Niaz, 2010). This means that POE Tasks can be used to reconstruct students' conceptions.

POE learning principles according to Usmeldi (2018) and Samsudin, et al. (2019) are as follows:

1) *Predict* (P): Predicting is the process of making guesses about a phenomenon or problem presented. Students predict the answer to the problem given and write their prediction with reasons (Khunsawat, et al., 2015). Students make initial guesses according to their abilities. The aim is to reveal students' conceptions of a particular concept or phenomenon.
2) *Observe* (O): In the observing step, students observe what happens. Students can observe the demonstrations presented, carry out experiments, record what is observed, and relate it to predictions according to the results of the observations (Wang, 2024; Chen, 2022). The aim is to facilitate students to observe physical phenomena that occur to create cognitive conflicts so that they can reconstruct old conceptions.
3) *Explain* (E): In this step, students are asked to provide an explanation of the results of predictions and observations according to the results of observing activities (Nasri, 2020). The aim is to facilitate students to construct their understanding.

Several research has used POE steps to change conceptions and reduce misconceptions in the field of physics (e.g. Furqani, Feranie, & Winarno, 2018; Nasri, 2020; Samsudin et al., 2021; Purwanto, et al., 2019; Keleş & Demirel, 2010; Muliyani, 2018). This identifies POE steps that can reconstruct students' conceptions. Therefore, this research develops POE Tasks which consist of three steps in the worksheet, namely predict, observe, and explain. In the final activity, students explain what happened according to the results of observations and compare it with the predicted results. If there

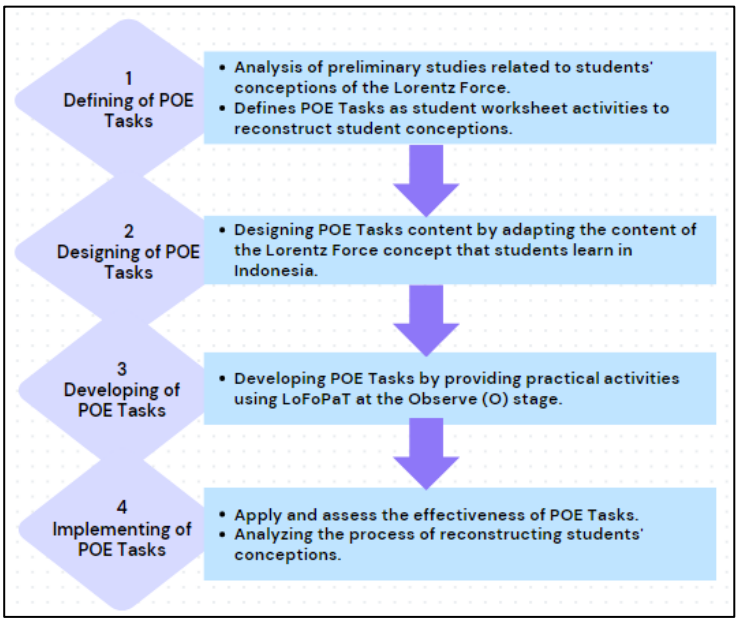
are discrepancies, this can encourage students to improve their initial conceptions and change these concepts into scientific concepts.

METHOD

Research Design

The research design has used a 3D+1I design. This design has been adopted from research by Aminudin et al. (2019), which consists of the Defining, Designing, Developing, and Implementing steps. Sequentially, the research flow is visualized in the flow chart in Figure 3.

Figure 3. Flow chart of POE Tasks research flow for 3D+1I design



Research Subject

The subjects of this research included high school students consisting of a total of 20 students, who were selected using a purposive sampling technique. The student is a student at a high school in Tuban district, East Java, Indonesia. The demographics of the research subjects are shown in Figure 4.

Research Instrument

The research instrument consists of POE tasks for the topic Lorentz force on a straight wire. The instrument was developed by including POE steps, which are shown in Table 3. Meanwhile, the pre-post test instrument used the Four-Tier Instrument on Lorentz Force (FILOF) with a Cronbach Alpa value is

0.78. FILOF was adapted from the Magnetism Conceptual Survey (MCS) by Li & Singh (2016) and the Electricity and Magnetism Conceptual Assessment (EMCA) by McColgan, Finn, Broder, & Hassel (2017), whose content is adapted to the school curriculum in Indonesia.

Figure 4. Demographics of research subjects

Data Analysis

The pre-posttest results were analyzed for description by categorizing students' conceptions into several categories in Table 1. Reconstruction of conceptions was categorized based on change categories Samsudin, et al. (2021), namely Acceptable, Not Acceptable, and No Change. Next, the effectiveness of POE Tasks in reconstructing students' conceptions was analyzed using Normalized-Change 〈C〉 in Equation (3), whose values were categorized according to Table 2.

Tabel 1. Categories of Students' Conception and the Score

Categories of Students' Conception	Tier				Score of Students' Conception
	1 (Option)	2 (Level Confidence)	3 (Reason)	4 (Level Confidence)	
Sound Understanding (SU)	T	S	T	S	4
Partial Positive (PP)	T	S	T	NS	3
	T	NS	T	S	
	T	NS	T	NS	
Partial Negative (PN)	T	S	F	S	2
	T	S	F	NS	
	T	NS	F	S	
	T	NS	F	NS	
	F	S	T	S	
	F	S	T	NS	
	F	NS	T	S	
	F	NS	T	NS	
Misconception (MC)	F	S	F	S	1
No Understanding (NU)	F	S	F	NS	0
	F	NS	F	S	
	F	NS	F	NS	
No Coding (NC)	IA				-

Description: True (T), False (F), Sure (S), Not Sure (NS), and Incomplete Answer (IA)

(Aminudin et al., 2019; Mufida, et al., 2024)

$$\langle C \rangle = \begin{cases} \frac{Post\ test\ value - Pre\ test\ value}{Maximum\ value - Pre\ test\ value}, & Post\ test > Pre\ Test \\ Drop, & Post\ test = Pre\ test = 100\ or\ 0 \\ 0, & Post\ test = Pre\ test \\ \frac{Post\ test\ value - Pre\ test\ value}{Pre\ test\ value}, & Post\ test < Pre\ test \end{cases}$$ Equation(3)

(Marx and Karen, 2007)

Tabel 2. Interpretation of N-Change Values

Nilai *N-change*	Interpretasi
$0{,}7 < \langle C \rangle \leq 1$	High
$0{,}3 < \langle C \rangle \leq 0{,}7$	Moderate
$0 \leq \langle C \rangle \leq 0{,}3$	Low
$-1 \leq \langle C \rangle < 0$	Negative

(Marx and Karen, 2007)

RESULT AND DISCUSSION

The research results and discussion sections are adjusted to the Defining, Designing, Developing, and Implementing (3D+1I) stages, where each section is explained as follows:

Defining

Regarding this research, POE Tasks include three steps. The first step is Prediction (P), where the teacher provides a conceptual event about the Lorentz force to students using a worksheet. This activity makes students curious and asks them to predict what should happen independently (Samsudin, et al., 2021b; Zhao, et al., 2021). In the second step, Observe (O), students observe scientific observations using LoFoPaT, and the teacher directs them to emphasize observations related to the concepts they observe. At this step, students experience cognitive conflict in which students are surprised based on previous intuitive thoughts and observation results, in addition to changing new conceptions (Samsudin, et al, 2019; Banawi, et al, 2019). Next, in the final step, Explaining (E), students are fully challenged about the inconsistency between observations and predictions by writing down the results of observations and concluding the concepts learned.

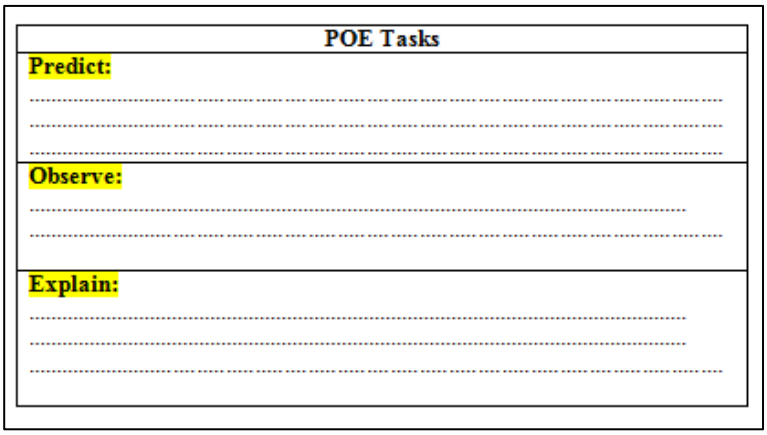
Designing

This stage presents the initial design of the POE Tasks. This research reconstructs the Lorentz's force concept which is based on students' needs based on students' pre-test results and refers to research by Mufida, et al. (2024). The concept of Lorentz's force on a reconstructed straight wire is described in detail in Table 3. Subsequent, a POE Tasks design has been created based on the literature review of previous research, which is shown in Figure 5.

Table 3. Lorentz's Force Sub-Concept Content

Sub-Concepts	Code
Determine the direction of the Lorentz force on a straight wire	SC1
Analyze the relationship between the magnitude of the Lorentz force and the strength of the electric current	SC2
Analyze the relationship between the magnitude of the Lorentz force and the length of the wire	SC3
Analyze the relationship between the magnitude of the Lorentz force and the strength of the magnetic field	SC4

Figure 5. Initial design of POE Tasks



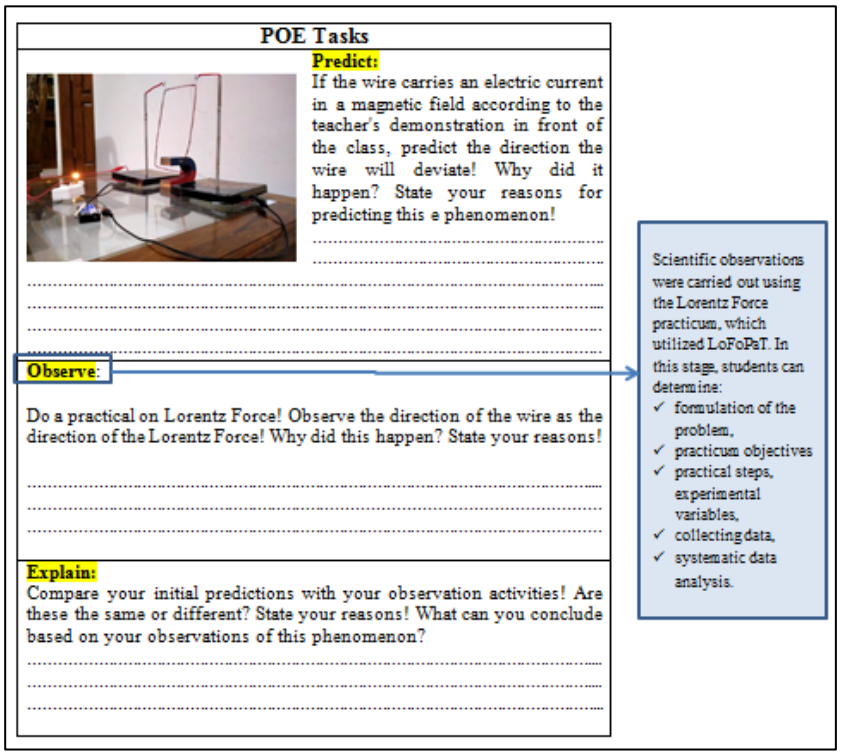
The POE Tasks design activity in Figure 5 consists of Predict (P), Observe (O), and Explain (E).

Developing

An example of the results of developing POE Tasks for the topic of Lorentz's force on a straight wire is presented in Figure 6.

According to Figure 6, the POE Tasks development stage is adding practical activities by utilizing the Lorentz Force Practical Tools (LoFoPaT) which have been developed previously. This is intended to replace old conceptions with scientific concepts and place students in a state of cognitive conflict.

Figure 6. Development of POE Tasks regarding Lorentz's force



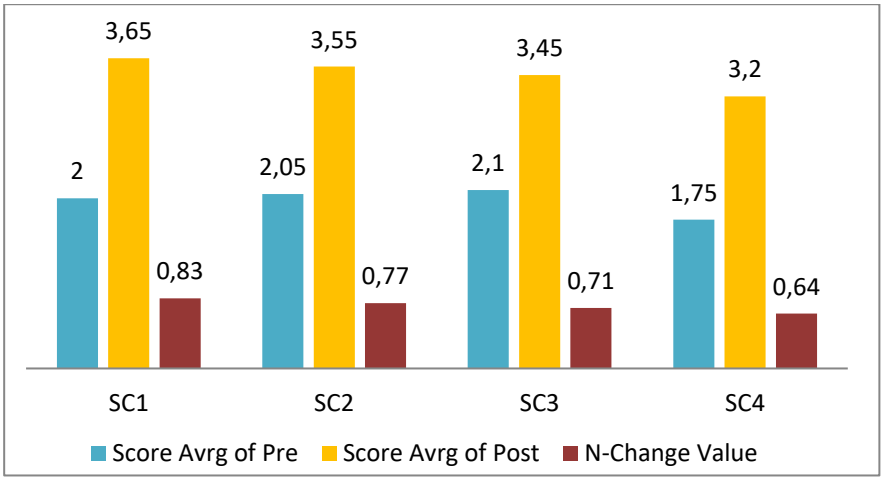
Implementing

The implementation stage is the use of POE Tasks for students. The results of this implementation are discussed by reviewing the pre-post test results which are analyzed using the student conception categories in Table 1. Meanwhile, the effectiveness of POE Tasks is based on the interpretation of the N-Change value in Equation 3 and Table 2. Discussion of the concept of Lorentz force on a straight wire refers to Table 3, which coded each sub-concept (SC). Research findings regarding the effectiveness of POE Tasks in reconstructing students' conceptions of Lorentz force are displayed in Figure 7.

According to Figure 7, the average pre-post score of students increases for each sub-concept. Thus, the effectiveness of POE Tasks according to Marx & Karen (2007) for sub-concept 1 (SC1) is high, sub-concept 1 (SC1) is high, sub-concept 2 (SC2) is high, sub-concept 3 (SC3) is high, and sub-concept 4 (SC4) is moderate. Overall, the average N-Change value is 0.73 (a high interpretation). It was credible that POE Tasks are effective in reconstructing students' conceptions about the Lorentz Force of straight wires. Besides that, POE Tasks require students to explain scientific concepts after carrying out step O (Observe) (Purwanto, et al., 2019; Wang, 2024; Harman &

Yenikalayci, 2022). Furthermore, adding practical activities using LoFoPaT can support changing students' conceptions into scientific conceptions, because practical activities condition students in a state of cognitive conflict (Samsudin, et al., 2019) and increase hands-on skills (Chen, 2022).

Figure 7. N-Change value for the effectiveness of each Lorentz's force sub-concept



In detail, the categories of students' conceptions before and after implementing POE Tasks are presented in Table 4. In Table 4, students are coded by number and gender with M (Male) and F (Female). The Lorentz Force sub-conceptions refer to Table 3, which are coded as SC1, SC2, SC3, and SC4. Students' conceptions are categorized according to Table 1 while conception reconstructions are categorized based on the change category Samsudin, et al. (2021a), namely Acceptable, Not Acceptable, and No Change.

Regarding Table 4, this research found that most students experienced reconstruction with changes in the Acceptable Change category. For example, student 03F (Female) for sub-concept 1 (SC1) about determining the direction of the Lorentz force in a straight wire, initially 03F was in the misconception (MC) category by remarking that the emergence of the Lorentz force was only caused by the attraction of magnets and 03F was very confident in the answer and reason. However, after achieving continuous learning using POE Tasks, 03F changed to a scientific conception with the Sound Understanding (SU) category. In line with research by Muliyani (2018) and Nasri (2020), POE Tasks can reduce misconceptions. Based on this change, it means that there is a reconstruction of students' conceptions.

Tabel 4. Type of Conception Change for Each Student Conception Category Change

Students' Code	Sub-conceptions	Categories of Students' Conception			Change' Category
		Pre-test		Post-test	
01M	SC1	NU	→	SU	Acceptable
	SC2	PP	→	SU	Acceptable
	SC3	PN	→	SU	Acceptable
	SC4	PN	→	PP	Acceptable
02F	SC1	PP	→	SU	Acceptable
	SC2	PN	→	PP	Acceptable
	SC3	PN	→	PP	Acceptable
	SC4	PP	→	PP	No Change
03F	SC1	MC	→	SU	Acceptable
	SC2	SU	→	SU	No Change
	SC3	MC	→	SU	Acceptable
	SC4	SU	→	PP	Not Acceptable
04M	SC1	PP	→	SU	Acceptable
	SC2	SU	→	SU	No Change
	SC3	SU	→	SU	No Change
	SC4	SU	→	SU	No Change
05M	SC1	SU	→	SU	No Change
	SC2	PP	→	SU	Acceptable
	SC3	PP	→	SU	Acceptable
	SC4	PP	→	SU	Acceptable
06F	SC1	SU	→	SU	No Change
	SC2	PP	→	SU	Acceptable
	SC3	SU	→	SU	No Change
	SC4	MC	→	PP	Acceptable
07F	SC1	PN	→	SU	Acceptable
	SC2	PN	→	SU	Acceptable
	SC3	MC	→	SU	Acceptable

Students' Code	Sub-conceptions	Categories of Students' Conception			Change' Category
		Pre-test		Post-test	
	SC4	PP	→	SU	Acceptable
08M	SC1	SU	→	SU	No Change
	SC2	NU	→	SU	Acceptable
	SC3	SU	→	SU	Acceptable
	SC4	NU	→	SU	Acceptable
09M	SC1	MC	→	SU	Acceptable
	SC2	SU	→	SU	No Change
	SC3	SU	→	SU	No Change
	SC4	SU	→	SU	No Change
10F	SC1	MC	→	PP	Acceptable
	SC2	NU	→	PP	Acceptable
	SC3	NU	→	PP	Acceptable
	SC4	MC	→	PP	Acceptable
11F	SC1	PP	→	SU	Acceptable
	SC2	MC	→	PP	Acceptable
	SC3	MC	→	PP	Acceptable
	SC4	MC	→	PP	Acceptable
12F	SC1	NU	→	PN	Acceptable
	SC2	MC	→	PP	Acceptable
	SC3	MC	→	PP	Acceptable
	SC4	NU	→	PN	Acceptable
13M	SC1	MC	→	PP	Acceptable
	SC2	MC	→	PP	Acceptable
	SC3	MC	→	PP	Acceptable
	SC4	MC	→	PN	Acceptable
14F	SC1	SU	→	SU	No Change
	SC2	SU	→	SU	No Change
	SC3	PP	→	PP	No Change
	SC4	MC	→	PP	Acceptable

Students' Code	Sub-conceptions	Categories of Students' Conception			Change' Category
		Pre-test		Post-test	
15M	SC1	MC	→	SU	Acceptable
	SC2	MC	→	SU	Acceptable
	SC3	PP	→	PP	No Change
	SC4	MC	→	PP	Acceptable
16F	SC1	PP	→	PP	No Change
	SC2	PP	→	PP	No Change
	SC3	MC	→	PP	Acceptable
	SC4	PP	→	PP	No Change
17M	SC1	NU	→	PP	Acceptable
	SC2	NU	→	PP	Acceptable
	SC3	NU	→	PP	Acceptable
	SC4	NU	→	PP	Acceptable
18F	SC1	MC	→	PP	Acceptable
	SC2	PN	→	PP	Acceptable
	SC3	PN	→	PP	Acceptable
	SC4	PN	→	PP	Acceptable
19M	SC1	MC	→	SU	Acceptable
	SC2	NU	→	PP	Acceptable
	SC3	MC	→	PP	Acceptable
	SC4	NU	→	PP	Acceptable
20F	SC1	PP	→	SU	Acceptable
	SC2	PP	→	SU	Acceptable
	SC3	SU	→	SU	No Change
	SC4	MC	→	SU	Acceptable

Description: Male (M), Female(F), Sound Understanding (SU), Partial Positive (PP), Partial Negative (PN), Misconceptions (MC), No Understanding (NU), Sub-Concepts 1(SC1),S ub-Concepts 2(SC2),S ub-Concepts 3(SC3), Sub-Concepts 3(SC3).

In Table 4, this research has found that from the Partial Positive (PP) category to Sound Understanding (SU) category such as students 02F, 05M, 11F. This implies that POE Tasks can persuade students who were initially unsure of

their conception to become confident in the concept of Lorentz' force. An example, for sub-concept 2 (SC2), there is a relationship between the magnitude of the Lorentz force and the strength of the electric current. This reconstruction occurred because according to Usmeldi (2018), Zhao et al., (2021), and Furqoni et al. (2018), POE Tasks begin with prediction activities, then students compare the initial predictions with the results of observations in the final stage. Finally, this change proves that students can have confidence in their correct conception.

Additionally, several students were categorized as No Change categories, such as students 04M, 09M, and 14F who did not experience reconstruction conception. They stayed in the Sound Understanding (SU) category. This finding suggests that the No Change type is positive. Nevertheless, in this study deficiencies were found, such as the case of reconstruction from the Misconceptions (MC) category to Partial Positive (PP) as in 13M students for all sub-concepts. This indicates that 13M students chose the correct answer and reason but are not sure about the answer, even though their conception is in accordance with the scientific conception. So, this research lacks the need for a special attitude to increase self-confidence in some students. This case is a weakness in the implementation of POE Tasks in this research.

This deficiency can occur because the implementation of POE Tasks does not involve discussion activities with classmates. The discussion activity should be included in a structured method in each step so that some students do not discuss with their friends or groups. Overcoming the shortcomings in this case reviewing research by Abdullah, et al. (2017) who utilized predict-discuss-explain-observe-discuss-explain (PDEODE) for a study on addressing students' misconceptions about condensation. Furthermore, research by Samsudin, et al. (2017) compared the implementation of PDEODE*E Tasks and POE Tasks. The result is that the implementation of PDEODE*E Tasks is more effective in reducing misconceptions than POE Tasks. This effectiveness is due to the addition of the Discuss (D), explore (E), and explain (E) stages. So it is relevant to this research if discussion activities are given after the Predict (P) and Observe (O) steps. Other research by Chen (2022) and Zhao, et al. (2021) also stated that integrating inquiry learning with POE strategies is effective and interesting for learning scientific concepts and increasing scientific epistemological beliefs. Based on the analysis of the shortcomings of this research, the researcher recommends using POE Tasks which involve structured discussion activities and adding inquiry learning activities for further research.

CONCLUSIONS

This research conclusion is POE Tasks were successfully developed, especially the addition of practical activities with the Lorentz Force Practicum Tool (LoFoPaT) at the Observe (O) step. As a result, POE Tasks are effective in reconstructing students' conceptions of Lorentz's force concept for each sub-concept, which is proven by the N-Change value of 0.73 (high effect). As a result, overall students experienced reconstruction from the No Understanding (NU), Misconceptions (MC), and Partial Negative (PN) categories to the Sound Understanding (SU) conception category and the Acceptable Change category. However, some students are still in the Partial Positive (PP) category, indicating that some students are not sure about the answers and reasons, even though their conceptions are in accordance with the conceptions of scientists. Yet, the reconstruction of students' conceptions can be said to be successful because of the effectiveness of the POE Tasks themselves, which include activities that contradict students from the initial prediction process, observing, to providing explanations. Accordingly, we suggest using POE Tasks to reconstruct students' conceptions from a category of No Understanding (NU), Misconceptions (MC), and Partial Negative (PN) to a scientific conception that is Sound Understanding (SU) about Lorentz's force.

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