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Development of Predict-Observe-Explain (POE) Strategy Assisted by Rebuttal Texts on Newton's Law Material with Rasch Analysis

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Abstract: This study aimed to develop Predict-Observe-Explain (POE) strategy with refutation text based on Newton's Law. The research design used was 4D (Define, Design, Develop, and Disseminate). The participants consisted of 31 students (15 male students and 16 female students) with an age range of 15-16 years selected from the tenth-grade of a public high school in Sukabumi, Indonesia. The instruments used were lesson plan validation sheets and a questionnaire containing 20 statements (11 positive and nine negative statements) with a Likert scale. The scores for positive statements move sequentially from four to one, while the scores for negative statements move sequentially from one to four. The analysis used in this study was the Rasch analysis. As a result, the lesson plan's codes for indicators have an unrevised assessment, while the Language, Concept, Strategy, Objective, and Time codes must be revised. The student responses indicated that all students did not agree with all negative statements, except for S26, S07, S28, and S01. Meanwhile, all students agreed to all positive statements given. Thus, it can be concluded that the POE strategy assisted by rebuttal text can better help students to understand Newton's Law material.

INTRODUCTION

Physics concept understanding is essential as the basis to understand a phenomenon. In its implementation, the learning process in the classroom can be a means that can provide students with a proper understanding of the explanation behind the existing phenomena. It is regulated in Permendikbud Number 21 of 2016; after studying physics, students are expected to have several competencies such as analyzing concepts, principles, and laws of physics, applying metacognition in explaining natural phenomena and solving life problems, and modifying or designing simple projects related to with the application of physics concepts. Based on this statement, the concept is one of the essential things students have in solving problems and using it to design simple projects. This is in line with the opinion stated by Ozkan & Selcuk (2015), "concepts are very important in physics." Students must understand scientific concepts after taking physics lessons. However, students often have initial concepts obtained based on their daily experiences (Ozkan & Selcuk, 2016).

The initial concepts that students have are usually not in line with scientific concepts. This state is known as alternative conceptions, misconceptions, conceptual difficulties, initial concepts,

and initial frameworks. (Gurel et al., 2015; Yürük & Eroğlu, 2016). In physics learning, alternative conceptions (misconceptions) are often found in several concepts such as 1) The concept of force and motion (Bayraktar, 2009; Liu & Fang, 2016; Narjaikaew, 2013; Poutot & Blandin, 2015; Saglam-Arslan & Devecioglu, 2010); 2) The concept of optical geometry (Kaltakci-Gurel et al., 2017); 3) The concept of electricity and magnetism (Leppavirta, 2012; Peşman & Eryılmaz, 2010; Preston, 2019), and; 4) the concept of fluid (Purwanto et al., 2018).

In the concept of force, some material becomes the basis for studying physics, especially in Newton's Law material. Saglam-Arslan & Devecioglu (2010), states that many students have difficulty understanding basic concepts such as force, acceleration, displacement, acceleration due to gravity, etc. Nonetheless, Newton's Law is essential because its application is easy to find for students in everyday life and becomes the basis for further studying Physics (Ferreira et al., 2019). Research results by Wenning (2008), reveal some alternative conceptions in Newton's Law of matter, namely (1) when the force acts on an object, then the object will move in the same direction as the working force, (2) when the force acting on the object is constant, then the object will move at the same speed (constant), (3) when there is no force acting, the moving object will eventually stop, (4) the acceleration of the falling object is affected by the object's mass, and (5) the gravitational force only works when the object falls. However, various alternatives can be used to anticipate this, one of which is the Predict-Observe-Explain (POE) strategy.

The POE learning strategy was first coined by White and Gunstone in 1992, as stated by Kearney et al. (2001). The POE strategy is a strategy that consists of three principles, namely, predict, observe, and explain. Predict-Observe-Explain is an efficient strategy to get students' ideas and encourage students to discuss their ideas. The POE strategy is based on the classic model by generating hypotheses and reasons about what might be true, gathering appropriate data, and discussing the results. The essential thing in the POE learning strategy is to allow students to observe activities, ask questions, predict, test the predictions, and refine hypotheses to get valid explanations (Berek et al., 2016).

The principles of the POE learning strategy, according to Usmeldi (2018), is as follows: 1) *Predict*. Predicting is a process of predicting a phenomenon or problem. Students predict the answers to the problems given and write the predictions along with reasons. Then, they make initial guesses according to their abilities. The goal is to reveal students' conceptions of a particular concept or phenomenon; 2) *Observe*. Students observe what happens. Students can observe the demonstrations, carry out experiments, record, and relate them to the predictions according to observations. The goal is to facilitate the students to observe physical phenomena to create cognitive conflicts; 3) *Explain*. Students explain the results of predictions and observations based on the results obtained from observing activities on this principle. The goal is to facilitate students to construct their understanding through scientific explanation activities with various media.

According to Ayvacı (2013), using the POE strategy allows students to predict an emerging phenomenon, observe the phenomenon, and explain to fix the gap between predictions and observations. Several studies have shown that the use of POE strategies can help students understand a concept and can even change their conceptions (Berek et al., 2016; Coştu et al., 2012; Jasdilla et al., 2019; Kala et al., 2013; Kibirige, 2014; Samsudin et al., 2017). In this case, the POE strategy can also be further

developed using a text's help, one of which is the rebuttal text.

Rebuttal text is a text that refutes alternative conceptions. Several studies have shown that rebuttal text helps students understand a concept (Caleon & Subramaniam, 2013; Kendeou & van den Broek, 2007; Nussbaum et al., 2017; Will et al., 2019). However, based on research by Setiawan et al. (2015), the use of text does not attract students' attention, so that students are less active in the learning process.

Students expect learning media that is attractive, easy to understand, easy to use, and stimulating to be active in the learning process. Therefore, teachers can use digital media in the learning process, including the text used. Digital media that attract students' interest can be used effectively to correct misunderstandings (Karaoglan Yilmaz et al., 2018; Samsudin et al., 2017). Also, digital media can visualize abstract concepts so that the text used will be easier to understand. The use of simulations on the media also allows students to carry out integrated investigations (control variables) to be more interactive (Jiang et al., 2018). Thus, this study aims to develop a Predict-Observe-Explain (POE) strategy assisted by rebuttal text on Newton's Law material, which will be analyzed using Rasch analysis.

Rasch analysis is a statistical method for describing people's interactions with items that can be understood as a psychometric tool in social science and have strong measurement properties (Brandt et al., 2015; Chan et al., 2014; Joyce & Yates, 2007; Mui Lim et al., 2009; Planinic et al., 2019; Rasch, 1960). Other than that, Chan et al. (2014) revealed that teachers could use Rasch analysis to develop test items as well as an essential tool that can provide relevant information related to student assessments for learning. Thus, these research results are expected to provide an overview of the Predict-Observe-Explain (POE) strategy development assisted by rebuttal texts on Newton's Law material.

METHOD

This research is development research using the 4D design (Define, Design, Develop, and Disseminate), which has been widely used in development research. The define stage was carried out by examining the POE strategy to be developed with the help of rebuttal texts. Meanwhile, the design stage was carried out to design the rebuttal text in the form of storyboards. Next, the development stage will integrate the rebuttal text into simulation media. The last is the dissemination stage in students' responses after using the Predict-Observe-Explain (POE) strategy assisted by rebuttal text on Newton's Law material analyzed by Rasch analysis using MINI STEP 4.3.1 software.

Participants

The participants in this study consisted of 31 students (15 male students and 16 female students) with an age range of 15-16 years in the tenth-grade of a public high school in Sukabumi, Indonesia. The participants were students who have never studied Newton's Law material. Thus, students can respond using the Predict-Observe-Explain (POE) strategy assisted by rebuttal text based on their understanding during the learning process.

Instrument

The instrument used was a validation sheet and student response questionnaires containing 20 statements (11 positive statements and nine negative statements) with four choices on a Likert scale, namely: Strongly Agree (SA); Agree (A); Disagree (D), and Strongly Disagree (SD). The instrument can be seen in Table 1.

Table 1. The Specification of Student Response Questionnaire.

Aspect	Code	Statement
Interest in studying physics	A1	I became more interested in physics when learning to use the Predict-Observe-Explain strategy assisted by rebuttal text.
	A2	It is easier for me to apply physics concepts in everyday life when learning using the Predict-Observe-Explain strategy assisted by rebuttal text.
	A3	I became confused in applying physics concepts in everyday life when learning to use the strategy.
Interest in using media	A4	I am interested in taking physics lessons while learning using exciting media.
	A5	I am not enthusiastic about taking Physics lessons even though I use exciting media.
	A6	Rebuttal text makes Newton's Law material more interesting to study.
	A7	Rebuttal text makes me sleepy when studying Newton's Law material.
	A8	Learn Newton's Laws with rebuttal text to make the material easy to remember.
	A9	Rebuttal text makes it difficult for me to study Newton's Law.
	A10	I like studying Newton's Law material with simulations and videos.
	A11	I am not interested when studying Newton's Law material with simulations and videos.
Passion for learning	A12	I enjoy studying Newton's Laws using the Predict-Observe-Explain strategy.
	A13	Learning with the Predict-Observe-Explain strategy is very tedious.
Usefulness for understanding concepts	A14	The Predict-Observe-Explain strategy makes me understand Newton's Law.
	A15	The Predict-Observe-Explain strategy makes it difficult for me to learn Newton's Law.
	A16	The Predict-Observe-Explain strategy assisted by rebuttal text is useful for studying Newton's Laws.
	A17	I do not understand Newton's Law material when studying using the POE strategy assisted by rebuttal text.
	A18	I realize my lack of understanding of Newton's Law after reading the text.
	A19	I become more active when I learned to use the Predict-Observe-Explain strategy assisted by rebuttal text.
	A20	I don't understand the meaning of the text.

Of the 20 statements in Table 1, 11 are positive statements, namely A1, A2, A4, A6, A8, A10, A12, A14, A16, A18, and A19. The rest are nine negative statements, namely A3, A5, A7, A9, A11, A13, A15, A17, and A20. The lesson plan validation sheet has nine indicators, which can be seen in Table 2.

Table 2. Lesson Plan Validation Indicators.

No.	Lesson Plan Validation Indicators
1	The lesson plan format is in the latest format.
2	Learning objectives are in line with Basic Competencies.
3	Learning indicators refer to Basic Competencies.
4	The indicators match the time allocation.
5	The Indicators can be easily measured.
6	The learning steps are in line with the strategy used.
7	The learning steps refer to learning indicators.
8	The lesson plan's language follows the rules of the Indonesian language.
9	The lesson plan can be used to construct students' conceptions.

Data Analysis

The four choices on the Likert scale, namely: Strongly Agree (SA); Agree (A); Disagree (D), and Strongly Disagree (SD). The scores for positive statements move sequentially from numbers 4 to 1. At the same time, the negative statement scores move sequentially from numbers 1 to 4. Furthermore, these scores will be processed in MINI STEP 4.3.1 software with Tables output (1) Variable (Wright) maps. Meanwhile, the lesson plan is validated through a validation sheet with nine indicators assessed based on the criteria of Valid without Revision (VwoR), Valid Revision (VwR), and

Invalid (IV). The results will then be processed with the Facets software using the Rater test.

RESULT AND DISCUSSION

The results obtained will be presented based on the research design used. The design sequence refers to the 4D design (Define, Design, Develop, Disseminate).

Define

The POE strategy consists of three stages, namely Predict, Observe, and Explain. Based on these three stages, abstract material such as Newton's Law requires assistance in the form of media. In this case, the rebuttal text can be an alternative that is integrated into the form of simulated interactive media (Figure 2). Interactive media provides learning material with a more attractive and informative appearance to optimize the learning process (Wiana, 2018). By integrating graphics, text, videos, simulations, animations, and images, the media can simulate various experiments, physics phenomena, and processes. The content taught becomes more attractive, can increase students' participation in the learning process, and improve physics concepts understanding (Jian-hua, 2012).

Design

Based on the POE strategy stages, the storyboard for the POE strategy assisted by the rebuttal text can be seen in Figure 1.

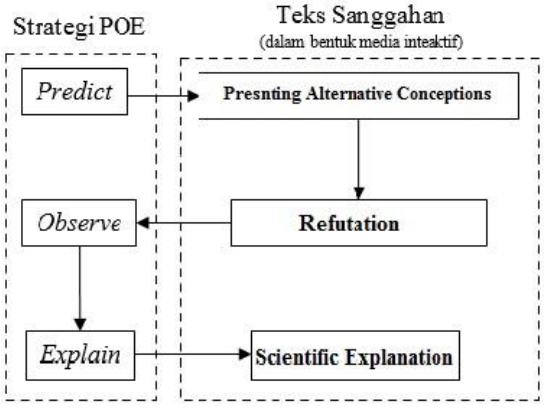


Figure 1. POE Strategy Storyboard.

In the early learning activities, a physics phenomenon is presented. Students are asked to predict the answers to the problems presented based on their conceptions. Next, students read the rebuttal text, which presents the possibility of alternative conceptions in general and the rebuttal sentence that the alternative conception is not a scientific concept. To convince students to change their conceptions, students observe through interactive media contained in the rebuttal text. After observing, the students compare the results of the predictions and observations. Finally, students' explanations are strengthened by explanations in the rebuttal text.

Develop

The development is on the rebuttal text used in the POE strategy. Usually, the text is presented on plain paper. However, in this study, the rebuttal text is integrated with interactive media. The description of the interactive media can be seen in Figure 2.

Students are asked to predict the likelihood of a moving car being forced to stop suddenly. Then students will fill in the answers on the application in the section provided. This step will last until the scientific explanations are suitable to the steps in Figure 1. The application can be operated on a smartphone or laptop.

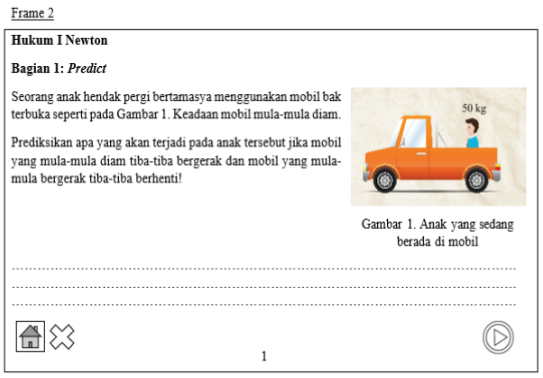


Figure 2. Rebuttal Text in the Form of Simulated Interactive Media.

Furthermore, the POE strategy assisted by rebuttal text is included in the lesson plan. The results of the lesson plan validation can be seen in Figure 3.

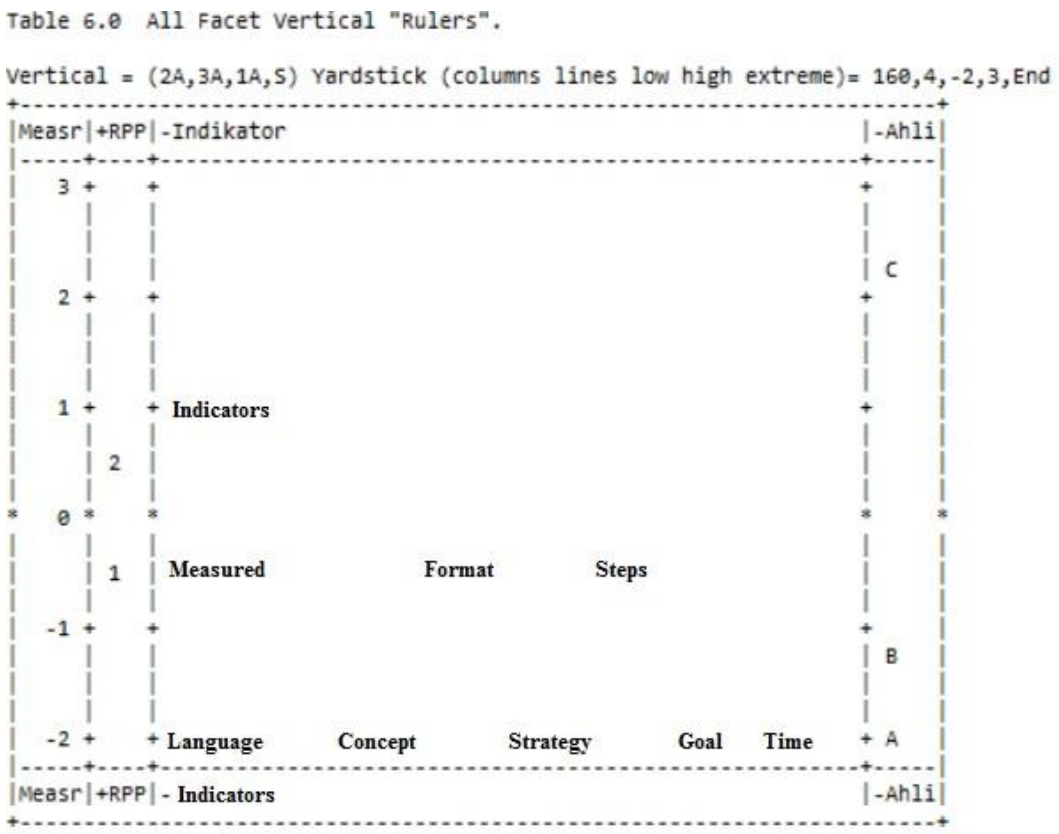


Figure 3. Lesson Plan Validation Results.

Based on Figure 3, the left part is the lesson plan, the middle part is the lesson plan validation indicator, and the right part is the validator. Code "format" is a validation indicator in the form of "lesson plan format according to the latest format," code "goal" is "learning objectives in line with Basic Competencies," code "indicators" are "indicators of learning refers to Basic Competencies," code "time" is "Suitability of indicators with time allocation," code "measured" is "indicators can and is easily measured," code "strategy" is "steps of learning in line with the strategy used," code "steps" are "learning steps refers to learning indicators, "the code" language "is" lesson plan uses language in line with the rules of the Indonesian language." The code "concept" is "lesson plan can be used to construct student conceptions." The lesson plan is valid for all validation indicators except for the code "indicator." However, the lesson plan is still said to be valid by experts A and B. Therefore, the lesson plan can be used even though it needs to be corrected according to the experts' inputs.

Disseminate

After the learning process, students fill out a questionnaire to determine their responses to learning using the Predict-Observe-Explain (POE) strategy assisted by rebuttal text on Newton's Law material. The results of the Rasch analysis can be seen in Figure 4.

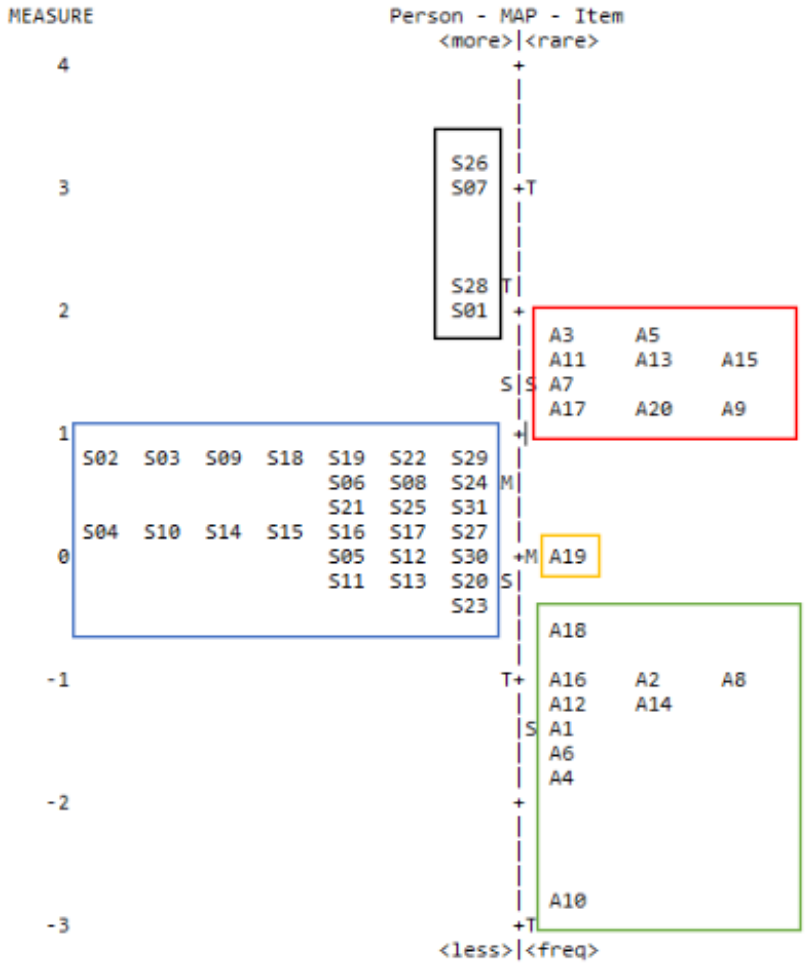


Figure 4. The Distribution of Student Responses to the Predict-Observe-Explain (POE) Strategy Assisted by Rebuttal Text.

Based on Figure 4, the left is the distribution of students (S01-S31), while the right is the distribution of items in the form of student responses (A1-A20). The statements submitted are in the form of positive and negative statements. Statements marked by a red box indicate that the student less disagrees, except for S26, S07, S28, and S01. The four students on the black box are students who agreed on all statements. Because the statements were in the form of positive and negative statements, there was a possibility that the four students were wrong when reading the statement.

The students' statements did not agree with were A3, A5, A11, A13, A15, A7, A17, A20, and A9. All statements that the student disagreed with were negative statements. Based on this statement, it can be seen that the students can apply the physics concepts in everyday life, be enthusiastic when participating in learning, make it easier for students to learn Newton's Laws, and can understand Newton's Law material. Therefore, the POE strategy assisted by rebuttal text can help students understand Newton's Law material and change their alternative conceptions. This is in line with Muliyani's (2018) research that the POE strategy combined with rebuttal text can reduce the number of misconceptions. Students are interested when learning using simulations and videos. Students' interest in texts combined with simulations and videos has the potential to change their conceptions. This is also

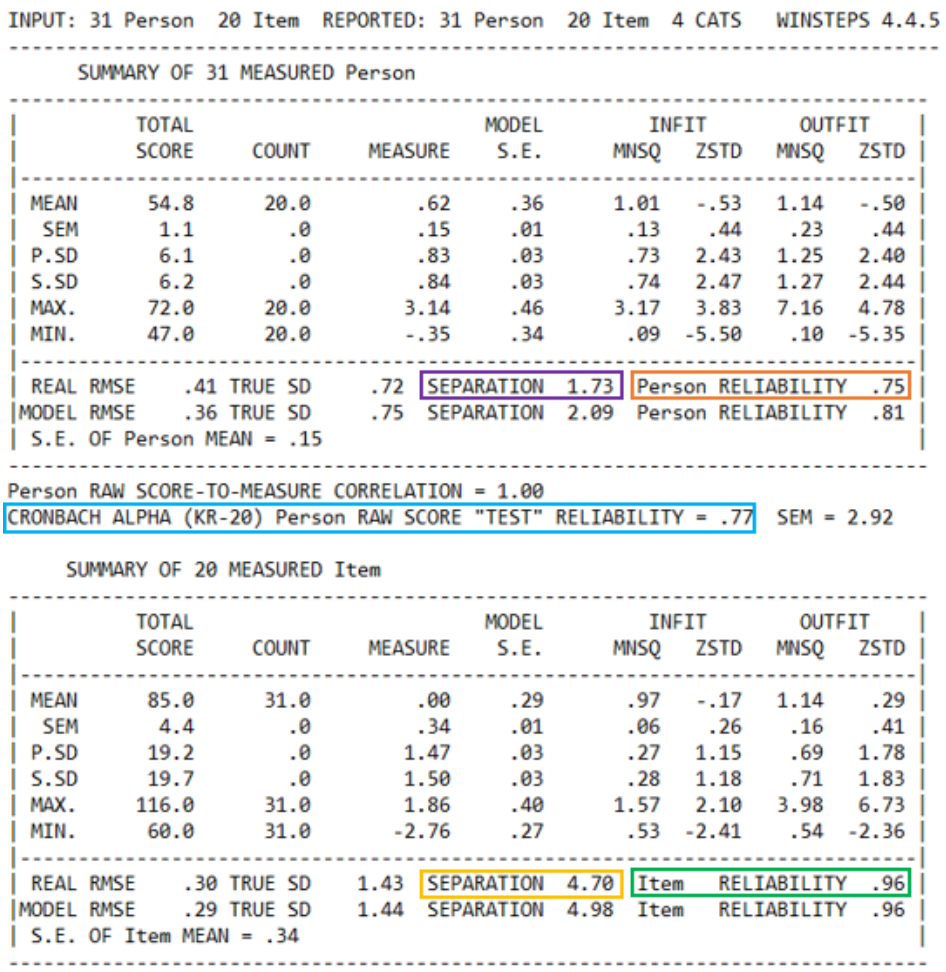
consistent with research by Caleon & Subramaniam, (2013) and Ozkan & Selcuk, (2015a) that the text combined with video is more effective in changing students' conceptions. The text used is also easy for students to understand.

Statement A19 is a statement agreed by all students except S11, S13, S20, and S23. The A19 statement is "I became more active when learning using the Predict-Observe-Explain strategy assisted by rebuttal text." Twenty-seven students stated that they were more active when learning using POE strategies assisted by rebuttal text. Finally, all students agreed to the statements in the green box. Most students agreed with the statements A18, A16, A2, A8, A12, A14, A1, A6, A4, and A10. All statements agreed by the students were positive statements. Based on this statement, it can be seen that by using the POE strategy assisted by rebuttal text in Newton's Law, students can realize their lack of understanding of Newton's Law material. Newton's Law material becomes easier to remember and understand. Students' awareness of their lack of understanding of a concept will allow them to change their conceptions and mental models. This is consistent with the Posner et al., (1982) that changing conceptions require certain circumstances. Students must be dissatisfied with existing concepts, and the new concepts must be understandable, reasonable, and useful.

In this case, the POE strategy obtained positive responses from the students. The rebuttal text in the form of simulated media is easier to use and can visualize Newton's Law's abstract nature. Several studies have also revealed the benefits of using POE learning strategies, namely improving student misconceptions (Coştu, 2008; Coştu et al., 2012; Kala et al., 2013; Kibirige, 2014; Radovanović & Sliško, 2012), improving students' understanding of concepts (Berek et al., 2016), improving students' competence (Usmeldi, 2018), changing students' mental model (Jasdilla et al., 2019), as well as the POE strategy can also be used to find out students' initial knowledge so that it helps teachers to identify misconceptions and find the right solutions to overcome them (Kibirige, 2014).

Meanwhile, interactive media in the rebuttal text also makes it easier for students to understand and visualize Newton's Law material. This is in line with (Nussbaum et al., 2017), who states that rebuttal texts in media are generally effective in increasing knowledge and improving students' conceptions. Besides, the use of media in the rebuttal text is intended to anticipate any misconceptions because the use of traditional texts can provoke misconceptions. Braasch et al., (2013) states that readers (students) experience misconceptions after reading science texts. So that the results of this study are in line with the research conducted by Muliyani, (2018) where POE strategy assisted by assistive media can have a bigger impact in changing students' conceptions.

Furthermore, the instrument used has a high-reliability value, as can be seen in Figure 5.



INPUT: 31 Person 20 Item REPORTED: 31 Person 20 Item 4 CATS WINSTEPS 4.4.5

SUMMARY OF 31 MEASURED Person

	TOTAL SCORE	COUNT	MEASURE	MODEL S.E.	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD
MEAN	54.8	20.0	.62	.36	1.01	-.53	1.14	-.50
SEM	1.1	.0	.15	.01	.13	.44	.23	.44
P.SD	6.1	.0	.83	.03	.73	2.43	1.25	2.40
S.SD	6.2	.0	.84	.03	.74	2.47	1.27	2.44
MAX.	72.0	20.0	3.14	.46	3.17	3.83	7.16	4.78
MIN.	47.0	20.0	-.35	.34	.09	-5.50	.10	-5.35

REAL RMSE .41 TRUE SD .72 SEPARATION 1.73 Person RELIABILITY .75
MODEL RMSE .36 TRUE SD .75 SEPARATION 2.09 Person RELIABILITY .81
S.E. OF Person MEAN = .15

Person RAW SCORE-TO-MEASURE CORRELATION = 1.00
CRONBACH ALPHA (KR-20) Person RAW SCORE "TEST" RELIABILITY = .77 SEM = 2.92

SUMMARY OF 20 MEASURED Item

	TOTAL SCORE	COUNT	MEASURE	MODEL S.E.	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD
MEAN	85.0	31.0	.00	.29	.97	-.17	1.14	.29
SEM	4.4	.0	.34	.01	.06	.26	.16	.41
P.SD	19.2	.0	1.47	.03	.27	1.15	.69	1.78
S.SD	19.7	.0	1.50	.03	.28	1.18	.71	1.83
MAX.	116.0	31.0	1.86	.40	1.57	2.10	3.98	6.73
MIN.	60.0	31.0	-2.76	.27	.53	-2.41	.54	-2.36

REAL RMSE .30 TRUE SD 1.43 SEPARATION 4.70 Item RELIABILITY .96
MODEL RMSE .29 TRUE SD 1.44 SEPARATION 4.98 Item RELIABILITY .96
S.E. OF Item MEAN = .34

Figure 5. Statistical Summary of the Instrument.

The orange box in Figure 5 shows the Person Reliability value of 0.75 in the "high" category, while the blue box shows the value of Item Reliability of 0.96 in the "excellent" category (Sumintono & Widhiarso, 2015). It means that the consistency of students' answers in answering the questionnaire was good and accompanied by excellent quality instruments. The interaction of the Person Reliability and Item Reliability is indicated by a green box, namely Cronbach Alpha of 0.77 in the "high" category. Thus, the instrument used has consistency in retrieving data. The purple box is the separation value for people, and the yellow box is for items. The values are 1.73 and 4.70, respectively. The two values must be calculated using Equation 1 to determine their meaning.

$$H = [(4 X separation) + 1] / 3 \quad (1)$$

The value of H in Equation 1 is the value of the strata. The results for strata person with a separation value of 1.73 is 2.64, which is included in the "High" category (Sumintono & Widhiarso, 2015). This means that students consisted of three groups. Meanwhile, the strata item results with a value of separation of 4.70 are 6.6, which is included in the "Excelent" category Sumintono & Widhiarso, (2015). It means that the instrument's groups if rounded up, consisting of 7 groups. Thus, the instrument used was of good quality in collecting data.

CONCLUSION

Based on the research results, it can be concluded that the Predict-Observe-Explain (POE) strategy can be assisted by rebuttal text, which is integrated into the form of interactive media so that it can be oriented towards the construction of students' conceptions. The POE strategy assisted by the rebuttal text is a combination of the POE strategy and the rebuttal text by inserting the POE strategy principles in parts of the rebuttal text to generate a new structure. Based on Rasch's analysis, the POE strategy assisted by rebuttal text can be applied to the learning process and receive students' positive responses.

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