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CONCEPTUAL UNDERSTANDING TEST INSTRUMENT ON ELECTRIC FORCE AND FIELD MATERIAL

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Abstract :
This study aims to develop a test instrument for understanding concepts on the material of force and electric field that meets the qualifications including aspects of validity and reliability. This study is a development with the ADDIE approach which stands for Analysis, design, development, implementation, and evaluation. This study was conducted at SMA Negeri 1 Banyuasin III with a sample of 30 students in class XII.3. The test instrument was declared feasible based on expert validation tests, the level of validity of the question items and reliability tests. Based on the research that has been done, the average score from the expert validation test was 3.64 which indicates a feasible category. At the level of validity of the tested question instrument if r-count > r-table then the question is declared valid. The r-table value used was 0.3610, in this test instrument there were 10 questions that were declared valid, with a range of r-count values of 0.3697 to 0.5362. In the reliability test, this instrument was declared reliable with a reliability value of 0.65.

Keywords: Forces and Electric fields, Test instruments, Understanding concepts.

INTRODUCTION

Education and its system are a dynamic thing (Krisnanto, 2021). Understanding concepts is a fundamental aspect of learning, especially in the fields of science and mathematics. Physics is one of the subjects that is difficult for students to understand. The main goal of science education is to prepare students to understand concepts (Mabruroh, 2017). Physics is not only a memorization science, but requires a deep understanding of concepts (Puri 2023). Physics studies natural phenomena physically and is written in mathematical form so that it emphasizes more on the aspect of understanding concepts (Liza 2021; Maulidina & Bhakti 2020). A well-understood concept will make it easier for students to apply knowledge to various situations and solve problems more effectively. Sika learning so far in class tends to memorize understanding, memorize the sounds of the law and remember the necessity to interpret everything learned (Missa, 2020).

Understanding concepts also plays an important role in improving the quality of learning. Students may find it difficult to understand the abstract theories and concepts learned in the field of physical science. Learning activities are very complex activities (Suhadi, 2018). Concepts that are not in accordance with the scientific understanding or the understanding of scientists in the field in question (Annisak, 2017). A deep understanding not only contributes to the improvement of students' academic performance, but is also closely related to the mastery of 21st century skills, namely the 4Cs *of critical*

thinking, communication, collaboration, and creativity). Teachers have a big challenge in guiding students to be able to compete at a global level. In addition to mastery of the material, teachers also need to equip students with 4C skills to face challenges in the era of increasingly complex technological development (Wulansari & Sunarya, 2023).

Students have difficulty in understanding the direction and shape of the electric field caused by several charges (Rahmawati & Suhendi, 2021). Concepts such as electric fields and Coulomb forces demand visualization-based instruments and multiple representations to support students' comprehension (Samsudin et al., 2018). Although several studies have discussed the importance of understanding physical concepts (Engelhardt & Beichner, 2004; Puri & Perdana, 2023), there are still shortcomings in evaluation instruments that really measure conceptual aspects, especially in force and electric field materials. Most of the question instruments used in schools emphasize mathematical calculations rather than indicators of concept understanding (Mundilarto, 2021), so they are not able to describe students' understanding in their entirety. Understanding is a mental process of adaptation and transformation of science (Lestari, 2020)

In addition, there are still few studies that develop test instruments with a systematic approach such as the ADDIE model and validate them based on indicators from the revision of the Bloom Taxonomy by Anderson (2001). Therefore, this study answers the need for the development of a valid and reliable instrument to measure concept understanding based on measurable and specific cognitive indicators.

Understanding concepts is an important indicator in assessing student learning achievement (Novak & Canas, 2019). The ability to understand concepts in physics can be interpreted as the ability of students to interpret concepts and understand the physical meaning of a concept (Engelhardt & Beichner, 2004). Conceptual understanding can be measured through a variety of indicators. According to Abdi, Mustafa, and Tenri (2021), there are seven indicators that reflect understanding concepts, namely interpretation, example, classification, summary, conclusion, comparison, and explanation. Anderson (2001) in his revision of Bloom's Taxonomy also identifies seven cognitive processes related to understanding concepts, namely: (1) interpreting, (2) exemplifying, (3) classifying, (4) summarizing, (5) inferring, (6) comparing, (7) explaning.

Based on the results of a joint observation by one of the physics teachers at SMA Negeri 1 Banyuasin III, it is known that many students still rely on memorizing formulas without really understanding and being able to apply concepts in various contexts, especially in force and electric field materials. Students' low understanding of concepts is influenced by various factors, such as inability to reproduce what has been learned, lack of interest and motivation, tendency to memorize formulas without understanding concepts, difficulty in solving equations with more than two variables, and lack of understanding of the content of questions (Riwanto, Azis, & Arafah, 2019).

According to Mundilarto (2021), many physics problems only require the ability to remember and solve problems mathematically without encouraging conceptual understanding, making them less effective as an evaluation tool for student understanding. Therefore, a valid and reliable test instrument is needed to measure the extent of students' understanding of these concepts. The concept of physics as an assessment instrument can be used to measure the cognitive structure of students (Wibawati & Supahar, 2016)

According to Gardner quoted from Zuhdi (2020), stating that there are at least three factors as the main obstacles for students in achieving concept understanding, namely: (1) the selection of learning methods that tend to tolerate the way of knowing unity, (2) the substance of the curriculum that tends to be non-contextual, and (3) the formulation of learning objectives is rarely oriented towards achieving deep understanding. The four-tier diagnostic test instrument is effective in revealing the level of students' understanding of concepts and misconceptions on Newton's Law material (Treagust. 2016). PysTT allows for fair and efficient measurement of students' conceptual understanding in Newtonian mechanics (Kurniawan. 2019).

Concepts in physics should be taught through real-life contexts to make them more meaningful (Kurnaz & Calik, 2017). Conceptual understanding instruments in physics are essential to measure students' ability to transfer knowledge and apply it in new contexts (Aini et al., 2021). The question instrument is one of the tools that can be used to measure students' understanding of concepts. A good instrument must meet the criteria of validity, reliability, and be able to measure indicators of concept understanding appropriately. However, in practice, many instruments are still not standardized, so the

measurement results do not accurately reflect students' understanding. Understanding of electric field concepts can be improved (Panjaitan, 2020). The FCI has been used extensively to assess the understanding of basic concepts in physics, particularly on the topic of force and motion (Hestener, 1992).

Therefore, this research aims to develop a question instrument that can better measure understanding of concepts, as well as test its validity and reliability. With the existence of tested instruments, it is hoped that the learning evaluation process can be more effective and provide a more accurate picture of the level of student understanding of a certain concept. Students with a good understanding of concepts find it easier to apply knowledge in new situations (Linder et al., 2020).

RESEARCH METHOD

This research was conducted at SMA Negeri 1 Banyuasin III, aiming to develop a test instrument for concept understanding on force and electric field materials. This research and development uses the ADDIE model. The ADDIE model consists of five stages, namely Analyze, Design, Development, Implementation, and Evaluation (Uwes, 2008). This research is limited to the Development stage. The development of instruments based on constructivism theory and revised Bloom taxonomy has proven to be effective in improving the accuracy of measuring concept understanding (Putra & Setiawan, 2019). This problem was developed using the concept understanding indicators from Anderson (2001) which has seven indicators based on the revised bloom taxonomy as seen in table 1:

Table 1. Concept Understanding Indicators

No	Concept Understanding Indicators	Definition
1	Interpreting	Changing from one shape to another
2	Exemplifying	Find specific examples or illustrations of a concept or principle
3	Classifying	Determining something that belongs to a category
4	*Summarizing*	Abstraction of general themes or main points.
5	Inferring	Depiction of logical conclusions from the information presented
6	Comparing	Dancing the relationship between two ideas, objects or similar things.
7	Menjelaskan (*explaining*)	Construct a causal model of a system.

Design Method

The analysis of question items was carried out quantitatively. Quantitative analysis can be reviewed from a classical approach that includes validity and reliability. Test instruments were developed to measure students' understanding of physics concepts based on factual and conceptual knowledge (Yulianti. 2021). Research instruments are considered good if their validity, validity, and reliability are categorized as valid and reliable. The validity of an instrument is related to the extent to which the measurement accurately measures what it is intended to do, and reliability is related to the extent to which the measurement is reliable due to its consistency (Arikunto, 2012).

According to research by Oktavia and Rahayu (2020), the validity and reliability of conceptual-understanding-based instruments need to be tested with expert tests and limited trials. Validity testing is an evaluation process to determine how well the measurement instrument can measure the concept or variable to be measured accurately and precisely. Validity is of two types, namely theoretical validity and empirical validity. Good validity and reliability in measuring students' understanding of concepts (Sufiani et al., 2023). The theoretical validity of the test instrument was carried out by a validator of Physicist at UIN Raden Fatah Palembang. Meanwhile, empirical validity is obtained from tests carried out by comparing the condition of the instrument concerned with criteria or a measure (Arikunto, 2018). The formula for the product moment is as follows:

$$r_{xy} = \frac{N\sum XY - (\sum X)(\sum Y)}{\sqrt{N\sum X^2 - (\sum X^2)\, N\sum Y^2 - (\sum Y^2)}} \quad (1)$$

Information:

rxy = The coefficient of the relationship between the variables X and Y
N = number of samples
X = item/item score
Y = total score of question items

The reliability test is the extent to which the measurement results get the same results even though the measurements are made many times under the same circumstances. The formula for *Cronbach alpha* reliability coefficient is as follows:

$$r_{xy} = \left(\frac{k}{k-1}\right)\left(1 - \frac{\sum \delta_b^2}{\delta_t^2}\right) \quad (2)$$

Where:
rxy = Reliability of the problem
k = Number of question items
σ_b^2 = Total grain variance
σ_t^2 = Varians total

After calculating the reliability coefficient Cronbach alfa (r_{xy}), Then the value is compared with the criteria Cronbach alfa for reliable instruments. An instrument can be said to be reliable if the reliability coefficient Cronbach alfa greater than 0,06 (r_{xy}>0,60). If the reliability coefficient Cronbach alfa less than 0,60 (r_{xy}>0,60) then the instrument was declared unreliable (Parinata & Puspaningtyas, 2021).

Analysis Stage

At this stage, a needs analysis related to the instrument to be developed is carried out by conducting a literature review of the student's level of concept understanding and interviewing physics teachers of SMA Negeri 1 Banyuasin III. To find out the use of concept comprehension test instruments in the school. The purpose of this study is to develop test instruments to measure students' understanding of concepts related to force and electric field materials. Based on the results of interviews with physics teachers at SMA Negeri 1 Banyuasin III, it is known that many students still memorize formulas without understanding the concepts of force and electric field. The results obtained at this stage are mostly students who admit that physics lessons are difficult (Natalia, 2017).

Design Stage

At this stage, the design of test instruments on force materials and electric fields is carried out based on concept understanding indicators. states that the results of the study (Septiani, 2016). The form of questions in this study is multiple choice. The instrument developed was 14 questions consisting of 7 indicators of concept understanding. In the interpreting indicator, there are questions number 1 and 2, because in these questions students are able to interpret the meaning of the electric field. The indicator for example is in questions number 3 and 4. The classification indicator is found in questions number 5 and 6. The summary indicator is found in questions 7 and 8. The indicator concludes that there are questions numbers 9 and 10. The comparison indicator is found in questions number 11 and 12. The indicator explains that there are questions numbers 13 and 14.
The use of indicators in each question includes several reasons such as:

1. Interpret
   Questions with this indicator are used to measure the ability to read and understand the meaning of electric force and electric field. This ability is important because it is the basis of the process of understanding concepts.
2. Exemplifies
   Questions with this indicator are used to measure students' ability to relate the concepts of electric force and electric field with real phenomena. This ability is important so that students not only understand concepts theoretically but also be able to apply them in daily life.
3. Classify

Questions with this indicator are used to assess students' ability to distinguish different types of electric fields based on charge configuration. This ability is important to help students understand when and how to apply electric field concepts in a variety of physics situations.

4. Summarize

   Questions with this indicator are used to measure the extent to which students can simplify the concept of electric force and electric field into a more understandable form. This ability is important so that students can remember the core of concepts without having to rely on memorizing formulas.

5. Conclude

   Questions with these indicators are used to test students' ability to draw conclusions based on the information provided, such as the relationship between the electric field and the movement of the test charge. This ability is important to help students understand how electric fields affect interactions between charges under various conditions.

6. Compare

   Questions with this indicator are used to measure students' ability to distinguish electric fields generated by different charge configurations. This ability is important so that students can understand how changes in the amount or type of charge affect the shape and direction of the electric field.

7. Explain

   Questions with these indicators are used to assess the extent to which students can explain the concepts of electric force and electric field in their own words. This ability is important so that students not only understand concepts numerically but also can provide logical and theory-based explanations.

Development Stage

Based on the design stage, the problems that have been successfully developed can be seen in table 2:

Table 2. Concept Comprehension Test Instrument

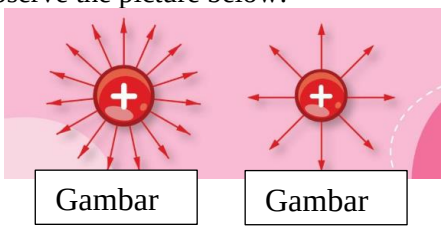
Concept Understanding Indicators	Indicator Description	Questions / Cognitive Level / Answers
Interpreting	Students are able to interpret the concept of electric fields	1. What is meant by an electric field? (C2) A. The area around a mass object where the force of gravity acts. B. The area around an electric charge where other charges experience an electric force. C. The area around a magnet where metal objects experience an attractive force. D. Empty space without the influence of any force. E. The area around an electric current where a magnetic force appears. 1. Answer: B. The area around an electric charge where other charges experience an electric force. Explanation: An electric field is the area around an electric charge that affects other charges with an electric force.
Interpreting	Students are able to interpret electrical forces	2. What is meant by electric force? (C2) A. The force that acts between two objects with mass. B. The force that only acts on positive charges. C. The force that occurs due to the interaction between two electric charges. D. The force that only acts on negative charges. E. The force that always repels all objects. Answer :

		C. The force that occurs due to the interaction between two electric charges. Explanation : Electric force is a force that acts between two electric charges. This force can be attractive or repulsive, depending on the type of charges involved..
Exemplifying	Students are able to provide examples of interactions between two objects with different or similar charges, and explain the results of these interactions.	1. Lesi is playing with a balloon at home. She rubs the balloon on a woolen cloth and brings it close to her hair. Lesi is surprised to see that the balloon makes her hair stand up without any help. In your opinion, are there any other examples of objects that can stick to a balloon if rubbed? with wool? (C2) A. large rock B. glass cup C. small piece of paper D. Dthick book D. ceramic cup Answer: C. A small piece of paper Explanation: A small piece of paper, such as a piece of paper, can stick to a balloon that has been negatively charged because of the attractive force between the negative charge on the balloon and the positive or neutral charge on the paper.
Exemplifying	Students are able to provide examples of interactions between two objects with different or similar charges, as well as explain the results of the interaction.	2. In a lab on making an electroscope, a student places a positively charged glass rod that has been rubbed on a wool cloth. When the glass rod is brought close to the electroscope, the leaves of the electroscope will open and move away from each other. Based on this event, which of the following objects will experience the same thing when brought close to the electroscope? (C2) A. A glass rod rubbed against silk cloth B. Plastic Cover that is rubbed on the hair C. Rubber rubbed on hair D. Balloon rubbed on hair E. Glass bottle rubbed on hair Answer: A. A glass rod rubbed against silk cloth A glass rod rubbed on silk cloth will acquire a positive charge, similar to glass rubbed on wool. When brought close to an electroscope, the effect will be the same, namely the leaves of the electroscope open and move away from each other.
Classifying	Students can classify electric charges into two types, namely positive charges and negative charges, and	3. Adi has 3 (three) objects that have different electric field forces: 1) Object A has a negative charge 2) Object C has a negative charge 3) Object D has a positive charge Which objects will repel each other if they are brought close together? (C2)

	provide examples of objects that have these charges.	A. 1 and 3 B. No objects repel each other C. 2 and 3 D. 1 and 2 E. 3 just Answer : D. 1 and 2. Explanation: Similar charges (negative and negative) will repel each other.
Classifying	Students can classify electric charges into two types, namely positive charges and negative charges, and provide examples of objects that have these charges.	4. Pay attention to the following statement ! 1) Similar electric charges repel each other 2) Objects are positively charged if the number of electrons is greater than the number of protons 3) Unlike electric charges attract each other 4) Objects are negatively charged if the number of protons is greater than the number of electrons The properties of the correct electric charge according to the statement are number? **(C2)** A. 1 and 2 B. 2 and 4 C. 2 and 3 D. 4 and 3 E. 1 and 3 Answer : E. 1 and 3 Explanation: Statement 1 is correct because similar electric charges (positive-positive or negative-negative) repel each other. Statement 3 is also correct because dissimilar electric charges (positive-negative) attract each other. Statement 2 is incorrect because a positively charged object occurs if the number of protons is greater than the number of electrons, not the other way around. Statement 4 is incorrect because a negatively charged object occurs if the number of electrons is greater than the number of protons.
Summarizing	Students are able to summarize the definition and basic principles of electric fields and how electric fields are produced by charges.	5. A student is doing a practicum, namely rubbing a plastic cover on his hair for a long time, about 20 seconds, causing the plastic cover to feel hot, then the student brings the plastic close to a small piece of paper. The piece of paper is then attracted to the cover. What are the results of the practicum? **(C3)** A. The plastic cover acquires a positive charge and attracts the negatively charged paper. B. There is a transfer of charge from the hair to the plastic, causing the paper pieces to be attracted. C. Friction between the hair and the plastic produces heat that attracts the paper pieces.

		D. The plastic cover turns into a magnet after being rubbed on the hair. E. Gravity causes the paper pieces to be attracted to the plastic. Answer : A. There is a transfer of charge from the hair to the plastic, causing the pieces of paper to be attracted. Explanation: When the plastic cover is rubbed on the hair, the plastic cover acquires a negative charge. When the negatively charged plastic cover is brought close to a small piece of paper, electrostatic induction causes the paper to become positively charged on the side close to the plastic, which causes an attractive force between the plastic cover and the piece of paper..
Summarizing	Students are able to summarize the definition and basic principles of electric fields and how electric field interactions are generated by charges.	6. In the laboratory, Dita conducted an experiment with an electroscope device that had two separated leaves. Dita then rubbed plastic on her hair and brought the plastic close to the electroscope device without touching it. After the plastic was brought near, Dita observed that the distance between the electroscope leaves increased. Based on this experiment, what can be concluded regarding the interaction that occurred with the plastic? (C3) A. The plastic is positively charged, thus attracting negative charges on the electroscope leaves. B. The plastic is neutral, thus not affecting the charges on the electroscope. C. The plastic is negatively charged, thus increasing the number of electrons on the electroscope. D. The plastic is negatively charged, thus causing charge induction on the electroscope and resulting in similar charges within the electroscope. E. The plastic is positively charged, thus causing the distance between the electroscope leaves to increase. Answer: D. The plastic is negatively charged, thus causing charge induction on the electroscope and resulting in similar charges within the electroscope. Explanation: When the plastic is rubbed on hair, the plastic gains a negative charge because electrons transfer from the hair to the plastic through a triboelectric process.
Inferring	Students are able to conclude the influence of the type of charge (positive or	7. If glass is rubbed with silk cloth, what happens? (C2) A. Silk cloth becomes positively charged B. Glass becomes negatively charged C. Electrons move from glass to silk cloth

	negative) on the direction and type of force acting.	D. Protons move from glass to silk cloth E. No transfer occurs Answer: C. Electrons move from glass to silk cloth Explanation: When glass is rubbed with silk cloth, electrons move from the glass to the silk cloth. The glass will lose electrons and become positively charged, while the silk cloth will gain electrons and become negatively charged. Therefore, electron transfer occurs from the glass to the silk cloth.
Inferring	Students are able to conclude the influence of the type of charge (positive or negative) on the direction and type of force that acts.	8. Two objects, A and B, are each electrically charged. When brought close together, they repel each other. Meanwhile, object C, which is neutral, is brought near object B, and object C is attracted to object B. Based on this phenomenon, what are the factors that influence the interaction between the objects? (C2) A. Distance between the objects and type of charge of the objects B. Type of charge of the objects and mass of the objects C. Mass of the objects and the material composition of the objects D. Distance between the objects and the material composition of the objects E. No influencing factors Answer: A. Distance between the objects and type of charge of the objects Explanation: The interaction between charged objects is influenced by the type of charge (whether like or opposite) and the distance between the objects. Like charges repel each other, while opposite charges attract. Distance affects the strength of the interaction through Coulomb's law.
Comparing	Students are able to conclude the effect on electric force	9. One of the factors that influences the magnitude of the electric force is? (C2) A. Mass of the object B. Type of material of the object C. Distance between two charged objects D. Duration of rubbing the object E. Speed of the object's movement Answer: C. Distance between two charged objects Explanation: The magnitude of the electric force acting between two charged objects is influenced by the distance between them and the amount of charge on each object, according to Coulomb's law. The closer the distance between the charged objects, the greater the electric force between them.

Comparing	Students are able to compare two different electric field charges and explain them	10. Observe the picture below:  Gambar Gambar In the image above, there are charges produced by electric fields. Which electric field is stronger from the two images above? (C2) A. The electric field around the charge in image B is stronger. B. The electric field around the charge in image A is stronger. C. The electric fields in both charges are equally strong. D. The electric fields around both charges cannot be compared. E. No electric field is produced. Answer: B. The electric field around the charge in image A is stronger. Explanation: This is because the field lines on the left charge are denser compared to those on the right charge.
Explaning	Students are able to explain what an electric field is, how it is produced by a charge, and how it affects a test charge.	11. When a silk cloth is rubbed on a balloon, the balloon becomes negatively charged. Why does the balloon become negatively charged? (C2) A. Electrons from the silk cloth move to the balloon. B. The balloon loses electrons and becomes negatively charged. C. Electrons from the balloon move to the silk cloth. D. The balloon loses protons and becomes negatively charged. E. The silk cloth produces new electrons that enter the balloon. Answer: A. Electrons from the silk cloth move to the balloon. Explanation: When the silk cloth is rubbed against the balloon, friction causes electrons to move from the silk to the balloon. This causes the balloon to have excess electrons and become negatively charged, while the silk cloth loses electrons and becomes positively charged.
Explaning	Students are able to explain what an electroscope is and how the	14. An electroscope is a tool used to detect the presence of electric charges in an object. When a negatively charged object is brought near the neutral head of the

	electroscope leaves become charged	electroscope, the leaves of the electroscope begin to open. This phenomenon occurs because? (C3) A. Electrons from the negatively charged object move to the leaves of the electroscope, making them negatively charged. B. Protons in the electroscope head move to the leaves, causing both leaves to have positive charges and attract each other. C. Electrons in the electroscope head move to the leaves, causing both leaves to have negative charges and repel each other. D. The negative charge from the object causes induction in the electroscope, causing protons to move to the leaves and make them repel each other. E. Electrons from the negatively charged object move to the electroscope. Answer: C. Electrons in the electroscope head move to the leaves, causing both leaves to have negative charges and repel each other. Explanation: When a negatively charged object is brought near the neutral electroscope head, electrons in the electroscope head are pushed to the leaves due to repulsive forces between like charges. As a result, the electroscope leaves become negatively charged and repel each other, causing the leaves to open.

RESULTS AND DISCUSSION

The results of the analysis of test instruments in this study showed the results of validation and reliability of the question items as follows:

The results of the validation of the question instrument from the expert validation can be seen in table 3:

Table 3. Expert Validation Results

No	Question Indicator	Assessment Score
1	Interpret	3
2	Describe	4
3	Exemplifies	4
4	Exemplifies	4
5	Classify	3
6	Classify	3
7	Summarize	4
8	Summarize	4
9	Drawing inferences	4
10	Drawing Inferences	3
11	Compare	4
12	Compare	4
13	Explain	3
14	Explain	4

Average	3,64

Based on table 3, the average is 3.64. It can be concluded that the concept understanding test instrument that is present in the validator is included in the category of good or valid and feasible to be used in research.

At this stage, a trial was carried out for students of grade XII.3 at SMA Negeri 1 Banyuasin III which amounted to 30 students. This is done to collect data that will be analyzed for validity tests and reliability tests of the test instruments whether they are really feasible to be used in research. The results of the validity of the question items are as seen in table 4 as follows:

Table 4 Question Validity Results

No Question	*Calculation*	Information
Question 1	0,4951	Valid
Question 2	0,3715	Valid
Question 3	0,5362	Valid
Question 4	0,4867	Valid
Question 5	-0,0649	Invalid
Question 6	0,3715	Valid
Question 7	0,3697	Valid
Question 8	0,0751	Invalid
Question 9	0,3715	Valid
Question 10	-0,2346	Invalid
Question 11	0,3764	Valid
Question 12	0,4511	Valid
Question 13	-0,1035	Invalid
Question 14	0,4222	Valid

The results of the rxy calculation are then compared with the r-table, which contains critical values as a reference in determining the significance of the relationship. If r-count is greater than or equal to rtable, then the question item is considered valid, while if the r-count is smaller than rtable, then the question is declared invalid. The validity test on the questions used a sample of 30 students. Thus, the r-table value used is 0.3610. Based on the comparison of the r-calculated value listed in table 4, the results were obtained that 10 questions were declared valid because they had a r-count value greater than the rtable, while 4 questions were declared invalid because they had a r-count value that was smaller than the rtable. The invalid questions are questions number 5, 8, 10, and 13.

The results of the analysis of the indicators of students' concept understanding on force and electric field materials are as follows:

1. Interpret

   Interpreting what is meant in this study is that students are able to interpret the electric force, direction and shape of the electric field around the charge. Interpreting is changing information from one type of information to another type of information (Anderson, 2001). In this study, it consists of questions number 1 and 2 which are declared valid to measure the understanding of concepts in interpreting indicators. The results of the indicator validity test interpret by correlating it with the total score of all indicators obtained $r_{hitung} > r_{tabel}$, So it can be concluded that questions with interpreting indicators are appropriate to measure students' understanding of concepts because $r_{hitung} < r_{tebel}$.
2. Exemplifies

   An example in this study is that students are able to provide examples of interactions between two charged objects of different types of the same type. Exemplifying is that students are able to give examples of what happens when students are able to give specific examples of general concepts or principles (Anderson, 2001). In this study, it consists of questions numbers 3 and 4 which are declared valid to measure concept understanding in the exemplary indicator. The results of the indicator validity test exemplify by correlating it with the total score of all indicators obtained $r_{hitung} > r_{tabel}$, So it can be concluded that the

questions with the exemplary indicators are suitable to measure students' understanding of concepts because $r_{hitung} < r_{tebel}$.

3. Classify

   Classifying in this study is that students are able to group various forms of electric fields. Classifying occurs when students know that an object (object or phenomenon) falls under the category of a concept or principle (Anderson, 2001). In this study, it consists of question number 6 which is declared valid to measure the understanding of concepts in the classification indicator. The results of the validity test of the indicator classify by correlating it with the total score of all indicators obtained a value $r_{hitung} > r_{tabel}$, So it can be concluded that the questions with classifying indicators are appropriate to measure students' understanding of concepts. On the other hand, question number 5 is declared invalid and cannot be used to measure students' understanding of concepts because $r_{hitung} < r_{tebel}$.

4. Summarize

   Summarizing in this study is that students can summarize the basic principles of electric fields. Summarizing occurs when students come up with sentences that represent the information received (Anderson, 2001). In this study, it consists of question number 7 which is declared valid to measure the understanding of concepts in the summarized indicator. The results of the indicator validity test summarize by correlating it with the total score of all indicators obtained $r_{hitung} > r_{tabel}$, So it can be concluded that questions with summarized indicators are appropriate to measure students' understanding of concepts. On the other hand, question number 8 is declared invalid and cannot be used to measure students' understanding of concepts because $r_{hitung} < r_{tebel}$.

5. Conclude

   Concluding in this study is that students can conclude the influence of the type of charge on the direction and type of force that works. Concluding occurs when students abstract concepts or principles that explain the example (Anderson, 2001). In this study, it consists of question number 9 which is declared valid to measure the understanding of concepts in the concluding indicator. The results of the indicator validity test concluded by correlating it with the total score of all indicators obtained $r_{hitung} > r_{tabel}$, So it can be concluded that the questions with the concluding indicators are appropriate to measure students' understanding of concepts. On the other hand, question number 10 is declared invalid and cannot be used to measure students' understanding of concepts because $r_{hitung} < r_{tebel}$.

6. Compare

   Comparing in this study is that students can compare different electric fields. Comparing involves the process of detecting similarities and differences between two or more objects, events, ideas and problems (Anderson, 2001). In this study, it consists of questions number 11 and 12 which are declared valid to measure the understanding of concepts in the comparative indicators. The results of the indicator validity test compare it by correlating it with the total score of all indicators obtained $r_{hitung} > r_{tabel}$, so that it can be concluded that questions with comparative indicators are appropriate to measure students' understanding of concepts because $r_{hitung} < r_{tebel}$.

7. Explain

   Explaining in this study Students can explain the concept of electric field in their own words, without just memorizing formulas. Explaining occurs when students are able to create and use a casual model in a system (Anderson, 2001). In this study, it consists of question number 14 which is declared valid to measure the understanding of concepts in the explanatory indicator. The results of the indicator validity test explain by correlating it with the total score of all indicators getting a score $r_{hitung} > r_{tabel}$, So it can be concluded that questions with explanatory indicators are appropriate to measure students' understanding of concepts. On the other hand, question number 13 is declared invalid and cannot be used to measure students' understanding of concepts because $r_{hitung} < r_{tebel}$.

The results of the reliability test used Cronbach's Alpha method for the instrument question. Considered reliable, the value of Crombach's Alpha reliability coefficient on the question must exceed 0.60. The results of the test in this study showed a Crombach's Alpha value of 0.65. Because the value

exceeds 0.60, it can be concluded that the question is declared reliable so that the question instrument can be used in the research. This shows that an instrument if tested repeatedly still shows the same results, meaning that the instrument is reliable. It means having regularity, stability, and consistency. The same results from the test do not mean the same score on every test. (Komarudin & Sarkadi, 2017).

The results of the study showed an increase in students' understanding of concepts after the application of project-based STEM approaches to force materials and electric fields. This is reflected in the significant increase in average scores and statistical test results. This improvement indicates that the integration of STEM approaches is able to shift learning from memorization to deeper conceptual understanding.

These findings are in line with previous research by Nugroho et al. (2020) and Sumarni & Widodo (2021), which also found that STEM approaches can improve critical thinking skills and understanding of physics concepts. However, this study specifically highlights the effects of the STEM approach on subindicators of the interpretation of electric field direction and shape, which have rarely been studied in depth in previous studies.

CONCLUSION

Based on this study, it can be concluded that the development of concept understanding test instruments on force and electric field materials developed at SMA Negeri 1 Banyuasin III is included in the feasible category in ensuring the accuracy and reliability of measurement results. Validity is an indicator of the extent to which the instrument can measure what should be measured, while providing an overview of the reliability of the consistency of the measurement results of the instrument. The results of the analysis of the question items showed a reliability value of 0.65 with the good category. In each question that has been declared valid, it can then be used to find out the understanding of the concept. The limitation of this research is that it only focuses on the material of Electrical Forces and Fields.

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