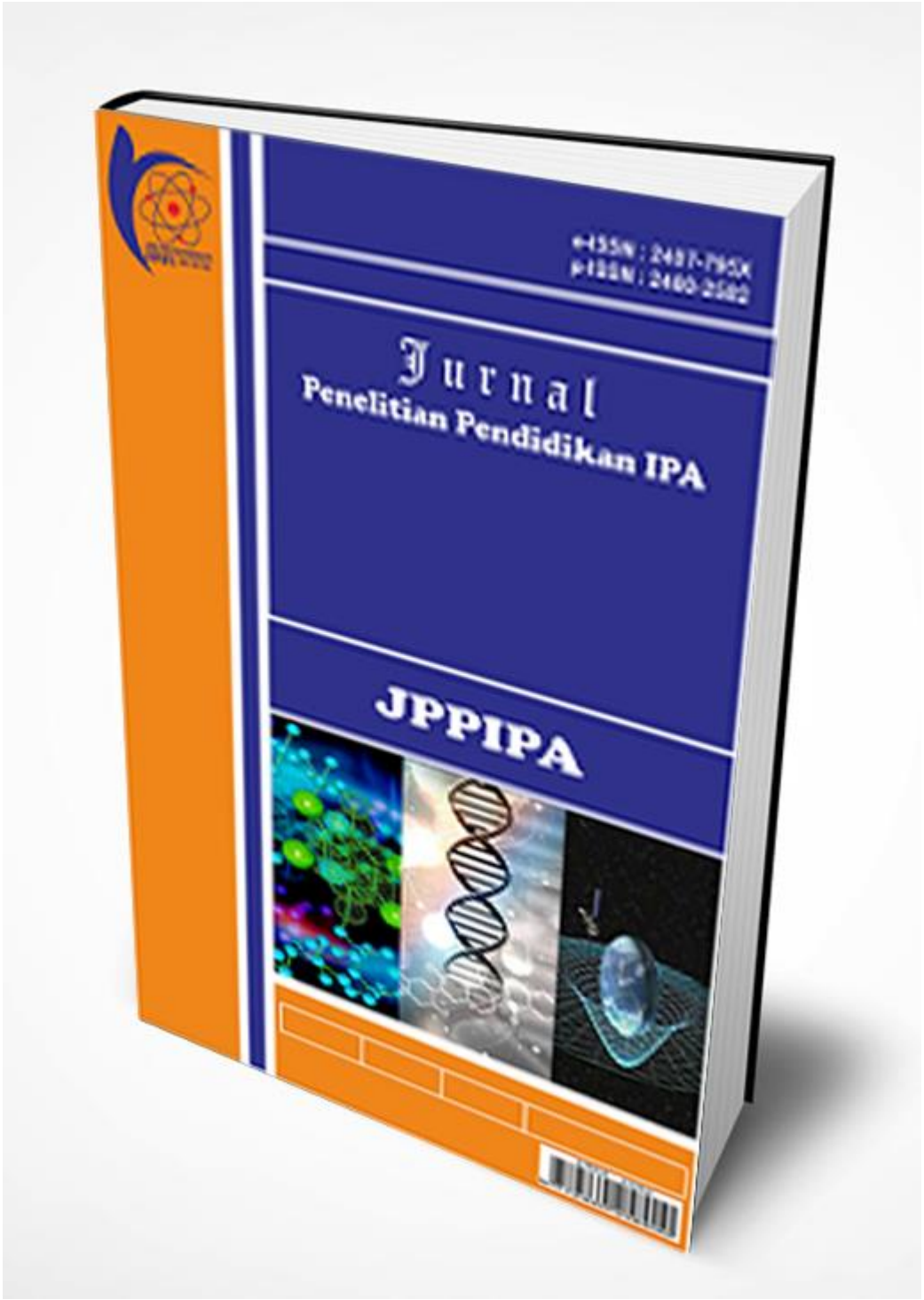

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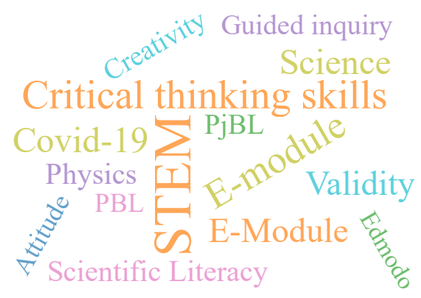

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The Development of Inquiry-Based Teaching Materials to Improve Physics Teacher's Conseptual Understanding

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Abstract: This development research aims to produce a product in the form of a valid and effective inquiry-based learning tool to increase the conceptual understanding of prospective physics teachers. The products that were developed include SAP (Satuan Acara Perkuliahan) or lecture unit, and LKM (Lembar Kerja Mahasiswa) or worksheet, Teaching Materials and conceptual understanding test instruments. The research design used is a 4D model consisting of Define, Design, Develop and Disseminate. Data collection techniques used validation sheets and evaluation tests for conceptual understanding. The validity data was analyzed using a Likert scale. Product effectiveness data was analyzed using the Gain standard. Product validity was assessed by three expert validators. Assessment by the validator using criteria that are valid to strongly valid. The N-gain test for conceptual understanding showed values of 88.23% in the high category for the indicator of restating the concept and 62.81% in the medium category for the indicator of presenting the concept. The improvement in students' conceptual understanding as measured by the N-Gain test results after taking a pre-test and post-test can be used to determine the effectiveness of teaching materials developed by researchers. The pretest average score for the conceptual understanding instrument was 47.50 and for the posttest average score was 87.73. This value was then analyzed using the N-Gain test with a calculation result of 77.88%, which means that this value is classified into the high increase category. So, it can be concluded that the development of inquiry-based teaching materials to increase conceptual understanding of prospective physics teachers is valid and effective.

Keywords: Development of teaching material; Inquiry; Conceptual understanding

Introduction

Science is essentially learning that emphasizes providing direct experience to develop competencies to identify, explore and understand the natural surroundings scientifically (Wilujeng, 2018). Physics as one of the elements of natural science has essential concepts to be included in problem-solving activities that can develop students' mastery of concepts. The ability to categorize problems based on basic principles rather than anything related to sentences will be considered more proficient in physics. Physics learning activities in schools require educators to carry out coaching students for the success of the learning process carried out. Educators are one of the important factors that can affect the learning process of students (Rahmawati & Edi, 2019).

Teaching materials as the main media in learning are used as a support in obtaining the expected goals. Teaching materials according to Sahidu, (2016) are a set of materials compiled by an educator in a systematic manner that can help solve student learning problems. Quality teaching materials are teaching materials that can provide skills and knowledge for students to achieve competency standards. In learning Physics, teaching materials must be developed in such a way as to form a more effective and innovative learning atmosphere. In the process of learning physics, educators must be able to make students not only memorize and know about physics concepts, but also must be able to make students understand and

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understand these concepts, and connect the linkages of these concepts with the real world. Therefore, educators need to develop teaching materials that can increase understanding of concepts and can connect with the real world. The physics teaching materials developed in this study are inquiry-based teaching materials.

It is important to apply inquiry learning because learning does not only focus on knowledge, but on students' process skills. Inquiry learning with a core activity in the form of investigation supports the creation of dynamic learning if it is done properly. Therefore, it is important for educators to understand the various types and phases of inquiry, so that students are ready to face the dynamics of education in the 21st century (Septiana et al., 2022) Inquiry is an approach to gaining knowledge and understanding by asking questions, observing, investigating, analyzing, and evaluating. An increase in learning outcomes is obtained through active group discussions, so that information can be found on the material being studied and the opportunity to process information (Aryani et al. 2019). The inquiry learning process will not be achieved if educators do not have knowledge of inquiry and it is known that inquiry learning is an international standard used in science learning (Fitriani, 2020).

The inquiry learning model was chosen because it fulfills the procedure category in learning, which is closely related to science process skills (Yulkifli, Yanto, Agustia, Ihsan, & Yohandri, 2020). As in the 2013 curriculum, learning materials consist of facts, concepts, principles and procedures. In order to fulfill the procedure category, the inquiry learning model is the right solution to get the highest achievements in science process skills and understanding concepts including scientific literacy (Satria, Yulkifli, & Ramli, 2019). Thus, it is necessary to develop inquiry-based teaching materials to increase students' understanding of the concepts of teacher candidates. The goal to be achieved in this study is to produce valid and effective inquiry-based teaching materials to increase the understanding of the concepts of physics teacher candidates.

Method

The type of research used in this study is research and development (Research and Development). The development model used in this study is the 4D model (Define, Design, Develop, and Disseminate) developed by Thiagarajan (1974). The Define stage carried out initial analysis, student analysis, task analysis, and specification of learning objectives. In the Design Stage, the draft RPP, LKM, and test instruments were prepared. The Develop stage is carried out to obtain an assessment from the validator of the product draft that has been developed. Validation was carried out by six validators consisting of three expert validators, in this case lecturers and three practitioner validators, in this case teachers. The Disseminate stage is carried out by providing a product that has been revised according to comments and suggestions from the validator. The research instrument used in this study was a learning device validation sheet to obtain an assessment as well as comments and suggestions from the validator on the device being developed**.**

The types of data obtained in this study are quantitative data, qualitative data and data on increasing understanding of the concept. Quantitative data was obtained from the results of the assessment on the validation sheet by an expert validator. Qualitative data were obtained from comments, input, criticisms, and suggestions by expert validators as outlined in the expert validity sheet. In addition, data on increasing understanding of concepts was also obtained through pre-tests and post-tests.

The validity of learning tools is the quality of learning tools (RPS, SAP, LKM, textbooks) which are assessed by validators using learning device validation sheets. The learning device is declared valid for use if the minimum level of validity reaches the valid category. Learning device validity sheets are used to obtain data on the validity of learning devices on content, consistency of components in the device and the correctness of the device being developed. The validation sheet is filled in by experts who act as validators to review and assess the developed learning tools. The validation sheet consists of RPS validation sheets, SAP, textbooks, LKM, and concept understanding tests. The form of this validation sheet is in the form of a table with columns containing the aspects to be observed. The validation sheet is filled in by experts who are competent in their fields. Validation provides a score based on aspects assessed with a range of 1-4 numbers. Table 1 shows the scores of expert validity assessments for learning tools.

Table 1. Expert validity assessment scores for learning devices

Score Interval	Category	Description
$1.0 \leq P \leq 1.75$	Strongly Invalid	Cannot be used and still requires consultation need consultation
$1.75 \leq P \leq 2.75$	Invalid	Can be used with multiple revisions
$2.75 \leq P \leq 3.25$	Valid	Usable with minor revisions
$3.25 \leq P \leq 4.0$	Strongly Valid	Can be used without revision

The interpretation of the percentage results obtained is shown in Table 2.

Table 2. Interpretation of validity percentage results

Percentage (%)	Score Interpretation Criteria
0-20	very weak
21-40	Weak
41-60	Enough
61-80	Valid
81-100	Strongly Valid

Increasing students' conceptual understanding and the effectiveness of learning tools can be calculated using the N-Gain test. The amount of N-Gain is calculated using the Formula 1.

$$g = \frac{S\ pos - Spre}{Smax - Spre} \quad (1)$$

Information:
$Spos$ = Posttest score
$SPre$ = Pretest score
$Smax$ = Maximum score

The results of the N-Gain calculations are then interpreted using the classification proposed by Meltzer (in Eka et al, 2017) as shown in Table 3.

Table 3. N-gain Clasification

Besarnya g	Interpretsi
g >0,7	Tinggi
0,3 <g ≤0,7	Sedang
g ≤0,3	Rendah

Result and Discussion

Understanding concepts is an important part of 21st century skill construction. Based on 5 21st century skill constructions namely information literacy, inventive thinking, effective communication, high productivity and leadership requires a good basic understanding of concepts (Abaniel, 2021). The ability to think in each learning process helps students understand concepts better (Thahir et al., 2020). Students with good thinking tendencies will have a better level of conceptual understanding than students with low critical thinking dispositions (Andayani et al. 2018). Understanding the concept is one of the objectives of each material delivered by the teacher, because the teacher is the guide for students to achieve the expected concept. Important for meaningful learning for understanding concepts. Of course, teachers expect that the understanding achieved by students is not limited to understanding that is able to connect concepts but implements it in everyday life (Yulianty, 2019). Physics subjects are sometimes considered difficult by students. Students need to be assisted in developing their conceptual understanding of physics which will enable them to relate physics to the real world. Students with good conceptual understanding of physics and problem-solving skills will be able to relate important information to what they already know without just memorizing it (Mbonyiryivuze et al., 2019).

This research produces products that have been developed in the form of: inquiry-based teaching materials, SAP and LKM related to understanding physics concepts, which have been tested in physics learning. The product has been tested for feasibility, practicality, and effectiveness of its use in learning. The feasibility of the teaching materials used in learning is seen from the value of the validity and reliability results obtained from the data provided by the expert validator. The validity value is obtained from the validation results carried out by 3 (three) expert validators. Teaching materials meet the feasible criteria if the validity assessment is in the valid criteria and the reliability calculation is in the reliable criteria.

The results of the recapitulation of the average pretest (pretest) and posttest (posttest) scores of students' ability to understand physics concepts show that the increase in students' conceptual understanding ability is quite high. The average N-Gain score for students' ability to understand physics concepts is 77.88% as shown in Table 4. The average N-Gain score when matched with the N-Gain score category in Table 4 is in the high category.

Table 4. Results of Data Analysis of N-Gain Scores for each indicator of Understanding of the Concept

Indicator	Pre-Test	Post-Test	N-Gain
Restating a concept	61.00	95.67	88.23%
Classify objects according to certain properties	54.50	93.17	84.46%
Provide examples and non-examples of concepts	45.67	92.00	85.47%
Presenting concepts in various forms of mathematical representation	42.33	79.00	62.81%
Develop necessary or sufficient conditions of the concept	33.00	78.83	68.46%

Based on Table 4, it can be seen that the maximum and minimum scores of the final test (posttest) are higher than the maximum and minimum scores of the initial test (pretest). This indicates that there is an influence of inquiry-based teaching materials on students' understanding of physics concepts. In addition, from the N-Gain data it can be seen that the ability to understand students' physics concepts has increased quite high, with an N-gain score of 88.23% which is in the high category. The N-gain score, which is in the high category, indicates that there is an influence on the development of inquiry-based teaching materials on students' understanding of physics concepts. This is in line with the results of

research conducted by Idhar et al., (2019) that inquiry learning can improve students' understanding of concepts and process skills so as to improve their learning outcomes. Inquiry activities are designed to promote students' conceptual understanding. Students can understand inquiry activities by visualizing how knowledge content relates to experiments and facilitates them in gaining in-depth understanding of topics (Kunwathnaphan et al., 2021). Inquiry learning strategies are recognized as having the ability to improve understanding of concepts. Brainstorming at the inquiry stage has the greatest contribution to increasing conceptual understanding, besides that it also contributes to carrying out plans (Nurmilawati et al., 2022).

The inquiry learning strategy has the potential to be a significant strategy for increasing conceptual understanding. In the inquiry learning process, the teacher gives questions from the easy level to the most difficult. Thus it will strengthen students' understanding and build stronger conceptual constructions (Laksana et al., 2019). Through practical inquiry work students can construct their scientific knowledge so that conceptual understanding can develop deeper and be able to change misconceptions that have occurred so far (Lu & Liu, 2018). Inquiry-based learning is able to encourage the development of students' conceptual understanding by deepening students' understanding of physics. It helps learners to generate their understanding of a phenomenon; hence they develop meaningful learning (Banda et al., 2021).

The results of the N-Gain recapitulation based on the indicators of the ability to understand students' physics concepts show an increase in their understanding of physics concepts in each indicator of students' understanding of physics concepts. The highest increase occurred in the indicator restating a concept with an N-Gain score of 88.23% in the high category and the lowest increase occurred in the indicator presenting the concept in various forms of mathematical representation with a medium category of 62.81%, as shown in Figure 1.

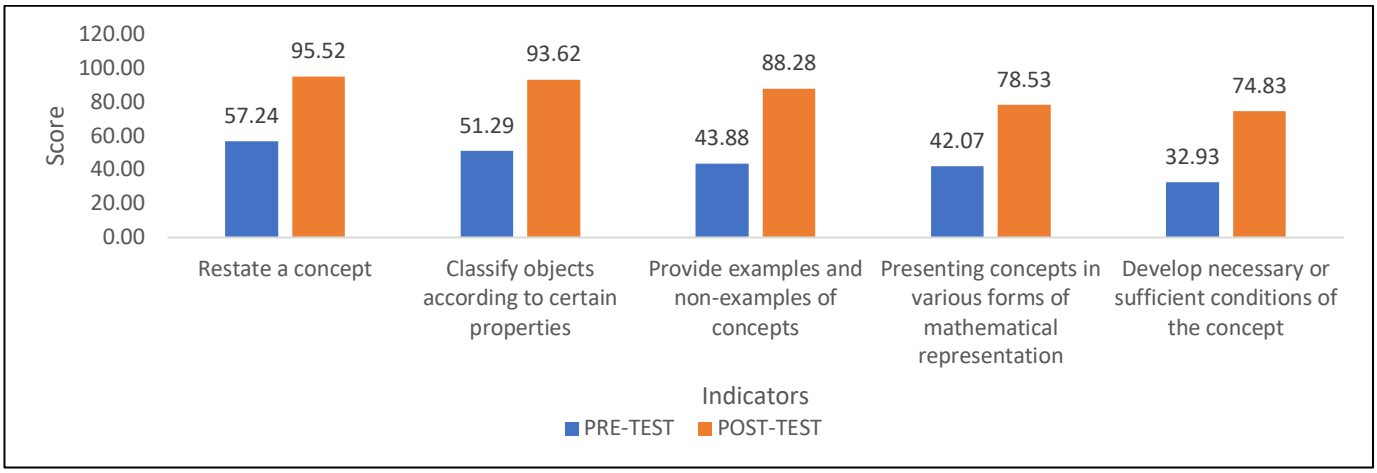

Figure 1. The differences in pre-test and post-test scores

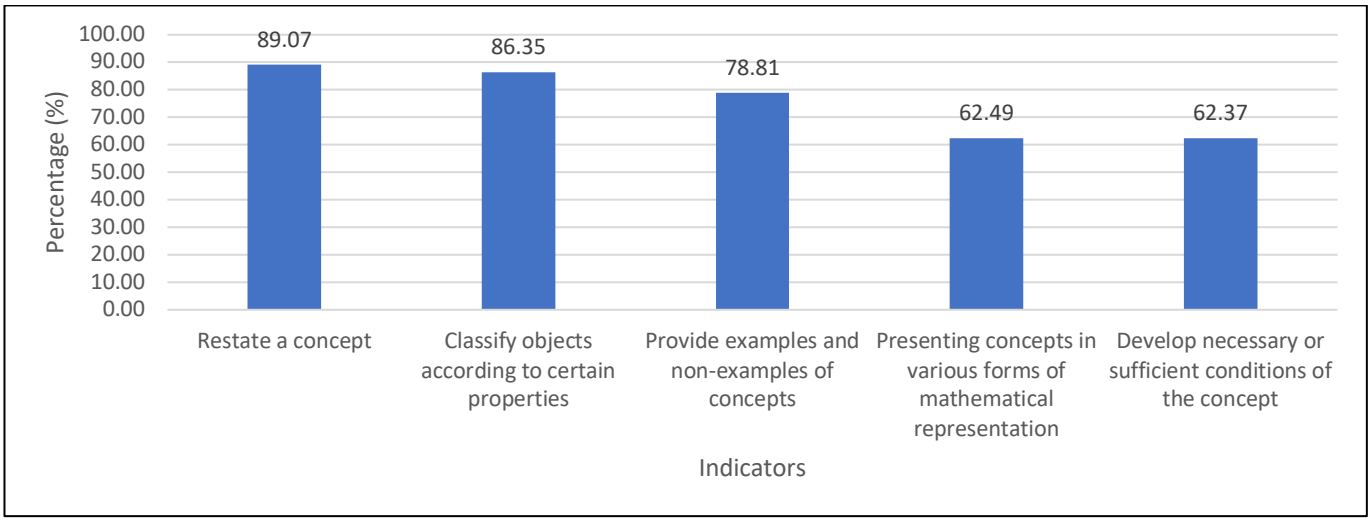

Figure 2. Differences in N-Gain Scores for each indicator

From Figure 1 it can be seen that the N-Gain indicators stating, classifying, giving examples, are in the high category, while the N-Gain indicators presenting and developing are in the medium category. Furthermore, it can also be seen that each indicator shows an increase in the ability to understand students' physics concepts.

In accordance with the results of the calculation of the average N-gain score above, it can be seen that the average N-gain score is 77.88% which is in the high category, which is in the concept understanding indicator. This shows that the development of inquiry-based teaching materials can improve students' ability to understand physics concepts. If viewed from each indicator of the ability to understand concepts, the development of inquiry-based teaching materials can improve students' ability to understand physics concepts. This is evidenced by the N-gain score on each indicator of the ability to understand concepts, namely the N-gain score restating a concept 88.23%, classifying 84.46%, giving examples of 85.47%, presenting concepts of 62.81% and developing requirements of 68.46%.

The effectiveness of teaching materials developed by researchers can be known through increasing students' understanding of concepts based on the results of the N-Gain test after being given pretest and posttest. Based on Table 1, it was found that the pretest average score for the conceptual understanding instrument was 47.50 and for the posttest average score was 87.73. This value is then analyzed using the N-Gain test with a calculation result of 77.88%, which means that the value is classified into the height increasing category.

Therefore, developing and monitoring conceptual understanding in the science curriculum is one of the main learning outcomes (Aydin et al., 2020). Learning outcomes in the academic field are conceptualized in terms of students' understanding of basic concepts. Learning achievement in terms of good conceptual understanding was only found in classes with higher interest in science activities related to cognitive activities. The activity appears to provide a productive starting point for addressing students' interests as well as encouraging their understanding of concepts (Höft et al., 2019).

Knowledge built from their previous experiences will also help students understand deeper concepts. The learning process in which students are required to interpret funds and design experiments has greater potential in increasing complex conceptual understanding (Husnaini & Chen, 2019). It is also important to create ideal classroom climatic conditions by adjusting the characteristics of the material. An ideal classroom climate will form good learning motivation. Of course, conceptual understanding of the material provided is better (Putra et al., 2018). Learning that can facilitate the development of good conceptual understanding is that which is able to create a conducive learning environment so that students have the opportunity to be more active in learning such as formulating questions related to phenomena. which will be discussed and then applied in an experiment according to the inquiry step (Parno et al., 2021).

Conclusion

This development research aims to produce a product in the form of an inquiry-based learning tool to increase the conceptual understanding of valid and effective physics teacher candidates. The products developed are: SAP, LKM, Teaching Materials and conceptual understanding test instruments. The learning devices developed in this study have met the valid criteria. The developed device has been validated by an expert validator to ensure its quality before being used in the learning process. The results of the validation for the developed device are included in the very valid criteria, and the results of the N-gain test show an increase in students' understanding of concepts. Based on data analysis, it was found that the pretest average value for the conceptual understanding instrument was 47.50 and for the posttest average value was 87.73. This value is then analyzed using the N-gain test with an average calculation result of 77.88%, which means that the value is classified into the high improvement category, so that the development of inquiry-based teaching materials is feasible to use to improve students' understanding of concepts.

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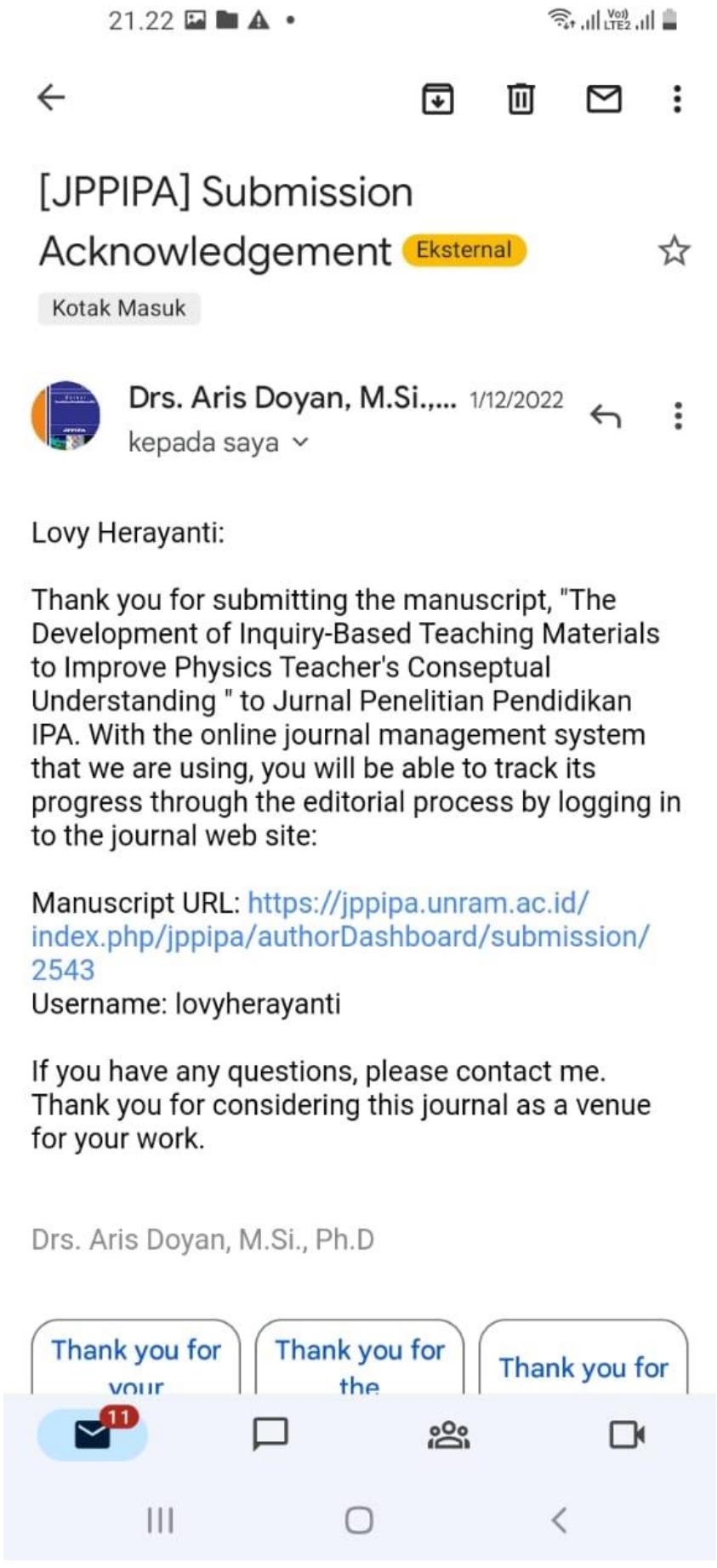
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The Development of Inquiry-Based Teaching Materials to Improve Physics Teacher's Conseptual Understanding

Abstract: This development research aims to produce a product in the form of a valid and effective inquiry-based learning tool to increase the conceptual understanding of prospective physics teachers. The products that were developed include SAP (Satuan Acara Perkuliahan) or lecture unit, and LKM (Lembar Kerja Mahasiswa) or worksheet, Teaching Materials and conceptual understanding test instruments. The research design used is a 4D model consisting of Define, Design, Develop and Disseminate. Data collection techniques used validation sheets and evaluation tests for conceptual understanding. The validity data was analyzed using a Likert scale. Product effectiveness data was analyzed using the Gain standard. Product validity was assessed by three expert validators. Assessment by the validator using criteria that are valid to strongly valid. The N-gain test for conceptual understanding showed values of 88.23% in the high category for the indicator of restating the concept and 62.81% in the medium category for the indicator of presenting the concept. The improvement in students' conceptual understanding as measured by the N-Gain test results after taking a pre-test and post-test can be used to determine the effectiveness of teaching materials developed by researchers. The pretest average score for the conceptual understanding instrument was 47.50 and for the posttest average score was 87.73. This value was then analyzed using the N-Gain test with a calculation result of 77.88%, which means that this value is classified into the high increase category. So, it can be concluded that the development of inquiry-based teaching materials to increase conceptual understanding of prospective physics teachers is valid and effective.

Keywords: Development of teaching material, inquiry, conceptual understanding

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Introduction

Science is essentially learning that emphasizes providing direct experience to develop competencies to identify, explore and understand the natural surroundings scientifically (Wilujeng, 2018). Physics as one of the elements of natural science has essential concepts to be included in problem-solving activities that can develop students' mastery of concepts. The ability to categorize problems based on basic principles rather than anything related to sentences will be considered more proficient in physics. Physics learning activities in schools require educators to carry out coaching students for the success of the learning process carried out. Educators are one of the important factors that can affect the learning process of students (Rahmawati & Edi, 2019).

Teaching materials as the main media in learning are used as a support in obtaining the expected goals. Teaching materials according to Sahidu, (2016) are a set of materials compiled by an educator in a systematic manner that can help solve student learning problems. Quality teaching materials are teaching materials that can provide skills and knowledge for students to achieve competency standards. In learning Physics, teaching materials must be developed in such a way as to form a more effective and innovative learning atmosphere. In the process of learning physics, educators must be able to make students not only memorize and know about physics concepts, but also must be able to make students understand and understand these concepts, and connect the linkages of these concepts with the real world. Therefore, educators need to develop teaching materials that can increase understanding of concepts and can connect with the real world. The physics teaching materials developed in this study are inquiry-based teaching materials.

It is important to apply inquiry learning because learning does not only focus on knowledge, but on students' process skills. Inquiry learning with a core activity in the form of investigation supports the creation of dynamic learning if it is done properly. Therefore, it is important for educators to understand the various types and phases of inquiry, so that students are ready to face the dynamics of education in the 21st century (Septiana et al., 2022) Inquiry is an approach to gaining knowledge and understanding by asking questions, observing, investigating, analyzing,

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The inquiry learning model was chosen because it fulfills the procedure category in learning, which is closely related to science process skills (Yulkifli, Yanto, Agustia, Ihsan, & Yohandri, 2020). As in the 2013 curriculum, learning materials consist of facts, concepts, principles and procedures. In order to fulfill the procedure category, the inquiry learning model is the right solution to get the highest achievements in science process skills and understanding concepts including scientific literacy (Satria, Yulkifli, & Ramli, 2019). Thus, it is necessary to develop inquiry-based teaching materials to increase students' understanding of the concepts of teacher candidates. The goal to be achieved in this study is to produce valid and effective inquiry-based teaching materials to increase the understanding of the concepts of physics teacher candidates.

Method

The type of research used in this study is research and development (Research and Development). The development model used in this study is the 4D model (Define, Design, Develop, and Disseminate) developed by Thiagarajan (1974). The Define stage carried out initial analysis, student analysis, task analysis, and specification of learning objectives. In the Design Stage, the draft RPP, LKM, and test instruments were prepared. The Develop stage is carried out to obtain an assessment from the validator of the product draft that has been developed. Validation was carried out by six validators consisting of three expert validators, in this case lecturers and three practitioner validators, in this case teachers. The Disseminate stage is carried out by providing a product that has been revised according to comments and suggestions from the validator. The research instrument used in this study was a learning device validation sheet to obtain an assessment as well as comments and suggestions from the validator on the device being developed**.**

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The interpretation of the percentage results obtained is shown in Table 2.

Table 2. Interpretation of validity percentage results

Percentage (%)	**Score Interpretation Criteria**
0-20	very weak
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Increasing students' conceptual understanding and the effectiveness of learning tools can be calculated using the N-Gain test. The amount of N-Gain is calculated using the formula:

$$g = \frac{S\ pos - Spre}{Smax - Spre}$$

Information:
$Spos$ = Posttest score
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The results of the N-Gain calculations are then interpreted using the classification proposed by Meltzer (in Eka et al, 2017) as shown in Table 3.

Table 3. N-gain Clasification

Besarnya g	Interpretsi
g >0,7	Tinggi
0,3 <g ≤0,7	Sedang
g ≤0,3	Rendah

Result and Discussion

Understanding concepts is an important part of 21st century skill construction. Based on 5 21st century skill constructions namely information literacy, inventive thinking, effective communication, high productivity and leadership requires a good basic understanding of concepts (Abaniel, 2021). The ability to think in each learning process helps students understand concepts better (Thahir et al., 2020). Students with good thinking tendencies will have a better level of conceptual understanding than students with low critical thinking dispositions (Andayani et al. 2018). Understanding the concept is one of the objectives of each material delivered by the teacher, because the teacher is the guide for students to achieve the expected concept. Important for meaningful learning for understanding concepts. Of course, teachers expect that the understanding achieved by students is not limited to understanding that is able to connect concepts but implements it in everyday life (Yulianty, 2019). Physics subjects are sometimes considered difficult by students. Students need to be assisted in developing their conceptual understanding of physics which will enable them to relate physics to the real world. Students with good conceptual understanding of physics and problem-solving skills will be able to relate important information to what they already know without just memorizing it (Mbonyiryivuze et al., 2019).

This research produces products that have been developed in the form of: inquiry-based teaching materials, SAP and LKM related to understanding physics concepts, which have been tested in physics learning. The product has been tested for feasibility, practicality, and effectiveness of its use in learning. The feasibility of the teaching materials used in learning is seen from the value of the validity and reliability results obtained from the data provided by the expert validator. The validity value is obtained from the validation results carried out by 3 (three) expert validators. Teaching materials meet the feasible criteria if the validity assessment is in the valid criteria and the reliability calculation is in the reliable criteria.

The results of the recapitulation of the average pretest (pretest) and posttest (posttest) scores of students' ability to understand physics concepts show that the increase in students' conceptual understanding ability is quite high. The average N-Gain score for students' ability to understand physics concepts is 77.88% as shown in Table 4. The average N-Gain score when matched with the N-Gain score category in Table 4 is in the high category.

Table 4. Results of Data Analysis of N-Gain Scores for each indicator of Understanding of the Concept

Indicator	Pre-Test	Post-Test	N-Gain
Restating a concept	61.00	95.67	88.23%
Classify objects according to certain properties	54.50	93.17	84.46%
Provide examples and non-examples of concepts	45.67	92.00	85.47%
Presenting concepts in various forms of mathematical representation	42.33	79.00	62.81%
Develop necessary or sufficient conditions of the concept	33.00	78.83	68.46%

Based on Table 4, it can be seen that the maximum and minimum scores of the final test (posttest) are higher than the maximum and minimum scores of the initial test (pretest). This indicates that there is an influence of inquiry-based teaching materials on students' understanding of physics concepts. In addition, from the N-Gain data it can be seen that the ability to understand students' physics concepts has increased quite high, with an N-gain score of 88.23% which is in the high category. The N-gain score, which is in the high category, indicates that there is an influence on the development of inquiry-based teaching materials on students' understanding of physics concepts. This is in line with the results of research conducted by Idhar et al., (2019) that inquiry learning can improve students' understanding of concepts and process skills so as to improve their learning outcomes. Inquiry activities are designed to

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promote students' conceptual understanding. Students can understand inquiry activities by visualizing how knowledge content relates to experiments and facilitates them in gaining in-depth understanding of topics (Kunwathnaphan et al., 2021). Inquiry learning strategies are recognized as having the ability to improve understanding of concepts. Brainstorming at the inquiry stage has the greatest contribution to increasing conceptual understanding, besides that it also contributes to carrying out plans (Nurmilawati et al., 2022).

The inquiry learning strategy has the potential to be a significant strategy for increasing conceptual understanding. In the inquiry learning process, the teacher gives questions from the easy level to the most difficult. Thus it will strengthen students' understanding and build stronger conceptual constructions (Laksana et al., 2019). Through practical inquiry work students can construct their scientific knowledge so that conceptual understanding can develop deeper and be able to change misconceptions that have occurred so far (Lu & Liu, 2018). Inquiry-based learning is able to encourage the development of students' conceptual understanding by deepening students' understanding of physics. It helps learners to generate their understanding of a phenomenon; hence they develop meaningful learning (Banda et al., 2021).

The results of the N-Gain recapitulation based on the indicators of the ability to understand students' physics concepts show an increase in their understanding of physics concepts in each indicator of students' understanding of physics concepts. The highest increase occurred in the indicator restating a concept with an N-Gain score of 88.23% in the high category and the lowest increase occurred in the indicator presenting the concept in various forms of mathematical representation with a medium category of 62.81%, as shown in Figure 1.

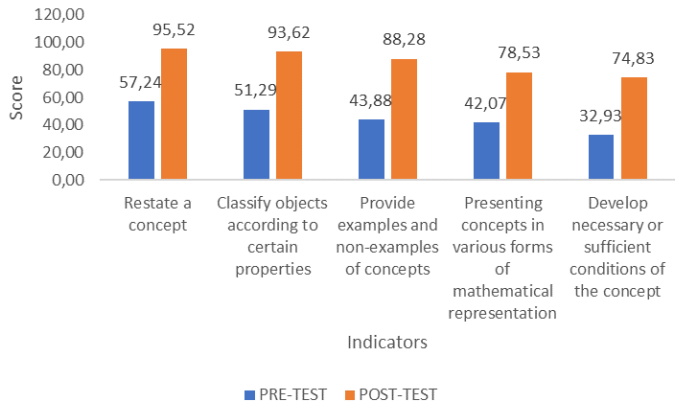

Figure 1. The differences in pre-test and post-test scores

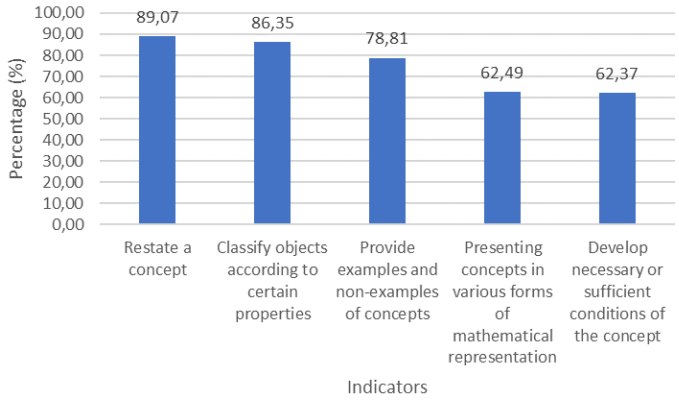

Figure 2. Differences in N-Gain Scores for each indicator

From Figure 1 it can be seen that the N-Gain indicators stating, classifying, giving examples, are in the high category, while the N-Gain indicators presenting and developing are in the medium category. Furthermore, it can also be seen that each indicator shows an increase in the ability to understand students' physics concepts.

In accordance with the results of the calculation of the average N-gain score above, it can be seen that the average N-gain score is 77.88% which is in the high category, which is in the concept understanding indicator. This shows that the development of inquiry-based teaching materials can improve students' ability to understand physics concepts. If viewed from each indicator of the ability to understand concepts, the development of inquiry-based teaching materials can improve students' ability to understand physics concepts. This is evidenced by the N-gain score on each indicator of the ability to understand concepts, namely the N-gain score restating a concept 88.23%, classifying 84.46%, giving examples of 85.47%, presenting concepts of 62.81% and developing requirements of 68.46%.

The effectiveness of teaching materials developed by researchers can be known through increasing students' understanding of concepts based on the results of the N-Gain test after being given pretest and posttest. Based on Table 1, it was found that the pretest average score for the conceptual understanding instrument was 47.50 and for the posttest average score was 87.73. This value is then analyzed using the N-Gain test with a calculation result of 77.88%, which means that the value is classified into the height increasing category.

Therefore, developing and monitoring conceptual understanding in the science curriculum is one of the main learning outcomes (Aydin et al., 2020). Learning outcomes in the academic field are conceptualized in terms of students' understanding of basic concepts. Learning achievement in terms of good conceptual understanding was only found in classes with higher interest in science activities related to cognitive activities. The activity appears to provide a productive starting point for addressing students' interests as well as encouraging their understanding of concepts (Höft et al., 2019).

Knowledge built from their previous experiences will also help students understand deeper concepts. The learning process in which students are required to interpret funds and design experiments has greater potential in increasing complex conceptual understanding (Husnaini & Chen, 2019). It is also important to create ideal classroom climatic conditions by adjusting the characteristics of the material. An ideal classroom climate will form good learning motivation. Of course, conceptual understanding of the material provided is better (Putra et al., 2018). Learning that can facilitate the development of good conceptual understanding is that which is able to create a conducive learning environment so that students have the opportunity to be more active in learning such as formulating questions related to phenomena. which will be discussed and then applied in an experiment according to the inquiry step (Parno et al., 2021).

Conclusion

This development research aims to produce a product in the form of an inquiry-based learning tool to increase the conceptual understanding of valid and effective physics teacher candidates. The products developed are: SAP, LKM, Teaching Materials and conceptual understanding test instruments. The learning devices

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developed in this study have met the valid criteria. The developed device has been validated by an expert validator to ensure its quality before being used in the learning process. The results of the validation for the developed device are included in the very valid criteria, and the results of the N-gain test show an increase in students' understanding of concepts. Based on data analysis, it was found that the pretest average value for the conceptual understanding instrument was 47.50 and for the posttest average value was 87.73. This value is then analyzed using the N-gain test with an average calculation result of 77.88%, which means that the value is classified into the high improvement category, so that the development of inquiry-based teaching materials is feasible to use to improve students' understanding of concepts.

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Result and Discussion

Understanding concepts is an important part of 21st century skill construction. Based on 5 21st century skill constructions namely information literacy, inventive thinking, effective communication, high productivity and leadership requires a good basic understanding of concepts (Abaniel, 2021). The ability to think in each learning process helps students understand concepts better (Thahir et al., 2020). Students with good thinking tendencies will have a better level of conceptual understanding than students with low critical thinking dispositions (Andayani et al. 2018). Understanding the concept is one of the objectives of each material delivered by the teacher, because the teacher is the guide for students to achieve the expected concept. Important for meaningful learning for understanding concepts. Of course, teachers expect that the understanding achieved by students is not limited to understanding that is able to connect concepts but implements it in everyday life (Yulianty, 2019). Physics subjects are sometimes considered difficult by students. Students need to be assisted in developing their conceptual understanding of physics which will enable them to relate physics to the real world. Students with good conceptual understanding of physics and problem-solving skills will be able to relate important information to what they already know without just memorizing it (Mbonyiryivuze et al., 2019).

This research produces products that have been developed in the form of: inquiry-based teaching materials, SAP and LKM related to understanding physics concepts, which have been tested in physics learning. The product has been tested for feasibility, practicality, and effectiveness of its use in learning. The feasibility of the teaching materials used in learning is seen from the value of the validity and reliability results obtained from the data provided by the expert validator. The validity value is obtained from the validation results carried out by 3 (three) expert validators. Teaching materials meet the feasible criteria if the validity assessment is in the valid criteria and the reliability calculation is in the reliable criteria.

The results of the recapitulation of the average pretest (pretest) and posttest (posttest) scores of students' ability to understand physics concepts show that the increase in students' conceptual understanding ability is quite high. The average N-Gain score for students' ability to understand physics concepts is 77.88% as shown in Table 4. The average N-Gain score when matched with the N-Gain score category in Table 4 is in the high category.

Table 4. Results of Data Analysis of N-Gain Scores for each indicator of Understanding of the Concept

Indicator	Pre-Test	Post-Test	N-Gain
Restating a concept	61.00	95.67	88.23%
Classify objects according to certain properties	54.50	93.17	84.46%
Provide examples and non-examples of concepts	45.67	92.00	85.47%
Presenting concepts in various forms of mathematical representation	42.33	79.00	62.81%
Develop necessary or sufficient conditions of the concept	33.00	78.83	68.46%

Based on Table 4, it can be seen that the maximum and minimum scores of the final test (posttest) are higher than the maximum and minimum scores of the initial test (pretest). This indicates that there is an influence of inquiry-based teaching materials on students' understanding of physics concepts. In addition, from the N-Gain data it can be seen that the ability to understand students' physics concepts has increased quite high, with an N-gain score of 88.23% which is in the high category. The N-gain score, which is in the high category, indicates that there is an influence on the development of inquiry-based teaching materials on students' understanding of physics concepts. This is in line with the results of research conducted by Idhar et al., (2019) that inquiry learning can improve students' understanding of concepts and process skills so as to improve their learning outcomes. Inquiry activities are designed to

promote students' conceptual understanding. Students can understand inquiry activities by visualizing how knowledge content relates to experiments and facilitates them in gaining in-depth understanding of topics (Kunwathnaphan et al., 2021). Inquiry learning strategies are recognized as having the ability to improve understanding of concepts. Brainstorming at the inquiry stage has the greatest contribution to increasing conceptual understanding, besides that it also contributes to carrying out plans (Nurmilawati et al., 2022).

The inquiry learning strategy has the potential to be a significant strategy for increasing conceptual understanding. In the inquiry learning process, the teacher gives questions from the easy level to the most difficult. Thus it will strengthen students' understanding and build stronger conceptual constructions (Laksana et al., 2019). Through practical inquiry work students can construct their scientific knowledge so that conceptual understanding can develop deeper and be able to change misconceptions that have occurred so far (Lu & Liu, 2018). Inquiry-based learning is able to encourage the development of students' conceptual understanding by deepening students' understanding of physics. It helps learners to generate their understanding of a phenomenon; hence they develop meaningful learning (Banda et al., 2021).

The results of the N-Gain recapitulation based on the indicators of the ability to understand students' physics concepts show an increase in their understanding of physics concepts in each indicator of students' understanding of physics concepts. The highest increase occurred in the indicator restating a concept with an N-Gain score of 88.23% in the high category and the lowest increase occurred in the indicator presenting the concept in various forms of mathematical representation with a medium category of 62.81%, as shown in Figure 1.

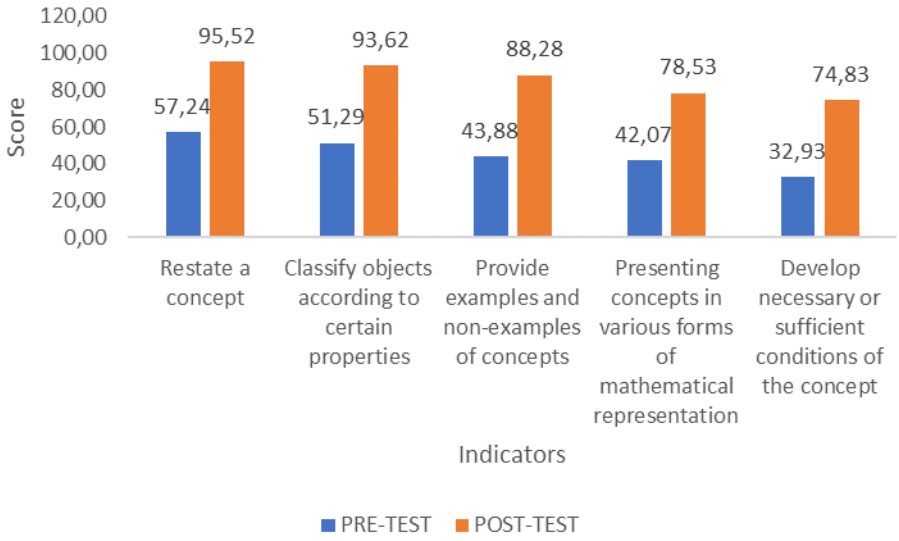

Figure 1. The differences in pre-test and post-test scores

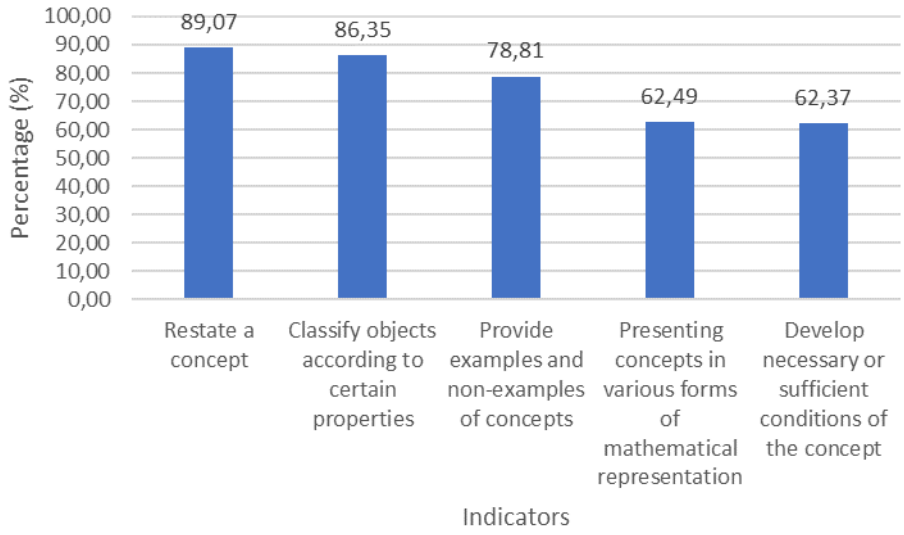

Figure 2. Differences in N-Gain Scores for each indicator

From Figure 1 it can be seen that the N-Gain indicators stating, classifying, giving examples, are in the high category, while the N-Gain indicators presenting and developing are in the medium category. Furthermore, it can also be seen that each indicator shows an increase in the ability to understand students' physics concepts.

In accordance with the results of the calculation of the average N-gain score above, it can be seen that the average N-gain score is 77.88% which is in the high category, which is in the concept understanding indicator. This shows that the development of inquiry-based teaching materials can improve students' ability to understand physics concepts. If viewed from each indicator of the ability to understand concepts, the development of inquiry-based teaching materials can improve students' ability to understand physics concepts. This is evidenced by the N-gain score on each indicator of the ability to understand concepts, namely the N-gain score restating a concept 88.23%, classifying 84.46%, giving examples of 85.47%, presenting concepts of 62.81% and developing requirements of 68.46%.

The effectiveness of teaching materials developed by researchers can be known through increasing students' understanding of concepts based on the results of the N-Gain test after being given pretest and posttest. Based on Table 1, it was found that the pretest average score for the conceptual understanding instrument was 47.50 and for the posttest average score was 87.73. This value is then analyzed using the N-Gain test with a calculation result of 77.88%, which means that the value is classified into the height increasing category.

Therefore, developing and monitoring conceptual understanding in the science curriculum is one of the main learning outcomes (Aydin et al., 2020). Learning outcomes in the academic field are conceptualized in terms of students' understanding of basic concepts. Learning achievement in terms of good conceptual understanding was only found in classes with higher interest in science activities related to cognitive activities. The activity appears to provide a productive starting point for addressing students' interests as well as encouraging their understanding of concepts (Höft et al., 2019).

Knowledge built from their previous experiences will also help students understand deeper concepts. The learning process in which students are required to interpret funds and design experiments has greater potential in increasing complex conceptual understanding (Husnaini & Chen, 2019). It is also important to create ideal classroom climatic conditions by adjusting the characteristics of the material. An ideal classroom climate will form good learning motivation. Of course, conceptual understanding of the material provided is better (Putra et al., 2018). Learning that can facilitate the development of good conceptual understanding is that which is able to create a conducive learning environment so that students have the opportunity to be more active in learning such as formulating questions related to phenomena. which will be discussed and then applied in an experiment according to the inquiry step (Parno et al., 2021).

Conclusion

This development research aims to produce a product in the form of an inquiry-based learning tool to increase the conceptual understanding of valid and effective physics teacher candidates. The products developed are: SAP, LKM, Teaching Materials and conceptual understanding test instruments. The learning devices

developed in this study have met the valid criteria. The developed device has been validated by an expert validator to ensure its quality before being used in the learning process. The results of the validation for the developed device are included in the very valid criteria, and the results of the N-gain test show an increase in students' understanding of concepts. Based on data analysis, it was found that the pretest average value for the conceptual understanding instrument was 47.50 and for the posttest average value was 87.73. This value is then analyzed using the N-gain test with an average calculation result of 77.88%, which means that the value is classified into the high improvement category, so that the development of inquiry-based teaching materials is feasible to use to improve students' understanding of concepts.

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[JPPIPA] Editor Decision

Eksternal

Kotak Masuk

22T 31/12/2022

Lovy Herayanti: We have reached a decision regarding your submission to Jurnal Penelitian

22T 31/12/2022

kepada saya

Lovy Herayanti, Habibi Habibi, Baiq Azmi Sukroyanti:

The editing of your submission, "The Development of Inquiry-Based Teaching Materials to Improve Physics Teacher's Conseptual Understanding ," is complete. We are now sending it to production.

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