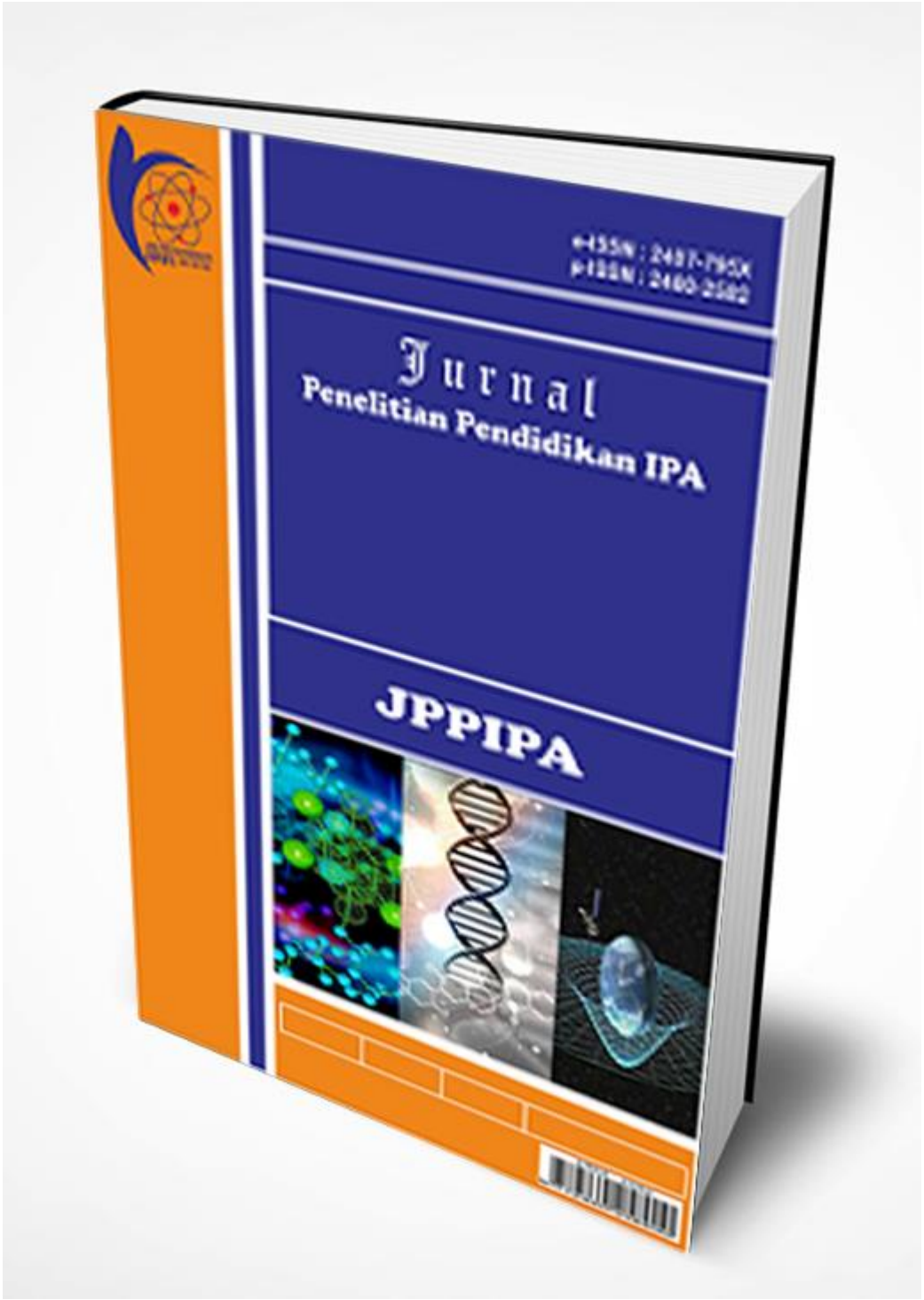

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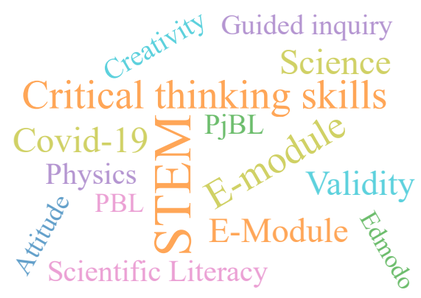

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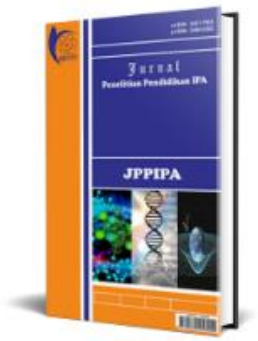

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Development of Inquiry-Based Teaching Materials to Improve the Creativity of Prospective Physics Teachers

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Abstract. This research is part of development research at the development stage. Inquiry-based teaching materials developed to increase the creativity of physics teacher candidates have been validated by experts and declared fit for use. At this stage, the aim is to determine the effectiveness of the developed teaching materials in increasing the creativity of prospective physics teachers. The effectiveness of teaching materials developed by researchers can be known by increasing students' creativity based on the results of the N-Gain test after being given a pretest and posttest. The creativity instrument used is a description test which is divided into verbal and figural creativity tests. The pretest average score for the verbal and figural creativity instruments was 62.71 and the posttest average score for creativity was 93.50 both verbal and visual. This value was then analyzed using the N-Gain test with a calculation result of 82.07%, 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 the creativity of prospective physics teachers is valid and effective.

Keywords: Creativity; Inquiry; Teaching material

Introduction

Education has an important role in facing world competition. In "Essential 21st Century Skills" requires humans to learn faster and more precisely according to today's technology. Greenstein (2012) explained that students living in the 21st century must master the 4C skills (Critical Thinking, Communication, Collaboration, and Creativity). The demand for "Essential 21st Century Skills" is an ability that must be possessed by current students as a provision to become qualified individuals to face world competition. Through the 2013 curriculum, the government accommodates students with student-centered learning to meet the demands of the 21st century, one of the demands of the 21st century is creativity.

Creativity is the ability to create new ideas as a solution to a problem (Munandar, 2014). Creative learning outcomes are a form of complex cognitive ability. In science learning creativity is related to learning motivation. Thus, educators as facilitators must have creative pedagogical skills, both teaching creatively and teaching creativity in science (Conradty & Bogner, 2019). The ability to collaborate and creativity is an important concern for the development of capabilities in this century. Creativity developed through collaborative learning is an effective way of impacting the ability to think in different ways and generate new ideas (Gündoğdu, & Ali, 2022). Creativity is also a key ability not only for success but also for survival. Thus to build a creative personality needs to be done by using learning strategies, techniques and media that require a creative process. Because indirectly creative habits will be formed (Boronat & Choueiry, 2022).

Creativity can be developed through inquiry-based learning by doing projects in small groups. Students' creativity can be honed while working in cooperative teams to define relevant and original questions, formulate hypotheses, plan and analyze data to answer questions, discuss results, and then communicate these results to a wider group (Rodríguez et al., 2019). During learning, creativity requires a safe environment that offers space for self-regulation and self-responsibility to support self-development so that it will form a good learning atmosphere (Conradty & Bogner, 2020). Self-regulation and learning to be responsible for themselves during learning will help students to practice their creativity (Suyidno et al., 2019). Educators need to

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understand the various types and phases of inquiry so that students are ready to face the dynamics of education in the 21st century (Susanti et al., 2022). The guided inquiry learning model is an inquiry-based learning model in which students seek answers to the problems they face themselves (Nurmayani et al, 2018). The inquiry learning model can direct students to realize what they have got during the learning process. Investigation and analysis abilities carried out by students are the core of the inquiry learning model.

The inquiry learning model was chosen because it fulfills the procedure category in learning, which is closely related to science process skills (Yulkifli et al, 2020). As in the 2013 curriculum, learning materials consist of facts, concepts, principles, and procedures. 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 et al., 2019).

Basic Physics is one of the compulsory subjects for physics students at LPTK. This course is given in the first semester because it is a requirement for subsequent courses. Abstract physics concepts make teachers experience difficulties in conveying the concepts to be taught to students. This is in line with the statement of Kusdiastuti et al (2016) that the characteristics of some abstract concepts in physics cause difficulties in their visualization and delivery to students. Therefore, as a teacher, it is necessary to use various types of learning methods and models that can facilitate students in obtaining good knowledge and then developing their creativity. The goal to be achieved in this research is to produce valid and effective inquiry-based teaching materials to increase the creativity of prospective physics teachers.

Method

This research is part of Research and Development. The development model used in this study is the 4D model (Define, Design, Develop, and Disseminate) developed by Thiagarajan (1974). This research is one of the stages of the development stage, namely developmental testing. This research was conducted at one of the universities in Mataram. The chosen sample consists of 30 first-semester students from the Basic Physics course. A quasi-experimental research design with a pre-test and post-test design was used at this stage. The learning tools and instruments used have been validated by three experts and declared valid for use in the trial phase. The creativity instrument used is in the form of a description test which is divided into verbal and figural creativity tests. Increasing the creativity and 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 Cheng et al (2004) as shown in Table 1.

Table 1. N-Gain Score Classification

Range	Conversion in percent	Category
g < 0,3	g < 30	Low
0,7 > g ≥ 0,3	70 > g ≥ 30	Medium
g ≥ 0,7	g ≥ 70	High

Result and Discussion

Creativity is essential for innovation and novelty. In creativity research in education, teachers must apply through learning with the right design (Kaplan, 2019). Creative results are not only new but must also be unique, appropriate to a particular task, and meaningful. Creativity can contribute to the development and cultivation of values that lead to meaningful, peaceful, sustainable, and wise lives (Glaveanu et al., 2020). If education is to determine better creativity practices in schools, then it is important to consider what kinds of tasks or creative thinking might be necessary for a given context and useful (Henriksen et al., 2020). People with good creativity will be able to come up with new ideas and then influence their surroundings to create new standards as well (Byrge & Gómez, 2019). Creativity also means all the unique productive endeavors of the individual. So, the world of creative education is very important in understanding a lesson or the meaning of all the activities carried out (Lian et al., 2020). In this decade, creativity has become a major requirement for developing all complex living systems to become increasingly digital. While teachers and education policymakers regard creativity as an important learning goal, it is important to develop these skills in the school environment (Vincent-Lancrin et al., 2019).

In this study, in developing the creativity of physics teacher candidates, teaching materials based on the inquiry model were developed. The inquiry model is one of the superior cognitive models for learning science in schools. Inquiry is considered to be quite effective in learning science and scientific skills. Inquiry is a learning strategy that can be used to teach students how to think (Arends, 2012). Chiappetta & Cobalt (2010) state that inquiry is a word used in the science education literature

to characterize a process that is actively involved in scientific thinking, investigating, and constructing knowledge. In other words, an inquiry is a process of solving a problem with scientific activities. So that the learning becomes meaningful and memorable (Sutiani, 2021). Inquiry generally involves emotions so that scientific procedure activities can be directed and able to answer curiosity (Sulistiyono, 2020). Through investigative activities involving scientific procedures, it is hoped that it can help develop the creativity of students.

This research produces products that have been developed in the form of inquiry-based teaching materials, SAP or lecture program units, and LKM or student worksheets related to creativity that 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.

Based on Table 2 below, it can be seen that students' initial abilities related to verbal creativity and figural creativity are different. This can be caused by the initial ability of students who prefer concepts that are related to figural. After learning to use the learning model used it is known that the verbal and figural abilities of students have increased. The increase experienced can be seen from the N-gain score obtained. Based on the table, the increase in verbal creativity increased by 31.72% while figural creativity increased by 8.79%. Based on these scores, it can be concluded that the creativity of students, especially verbal, increased more than their figurative creativity. This is caused by the applied model indicators. The learning model used provides opportunities for students to freely convey their creative ideas. They are given directions in correcting any wrong concepts, either verbally or figuratively. They are also allowed to solve existing problems by broadly providing ideas and solutions without being limited by existing answers.

Table 2. Creativity Data in General

	Verbal Creativity	Figural Creativity	Total Score
Pre-Test	2.05	4.22	62.71
Post-Test	4.60	4.75	93.50
N-Gain	31.72%	8.79%	82.07%

Figure 1 shows an increase in the creativity of students after learning to use inquiry learning. The difference in scores on verbal skills is quite large, which is equal to 2.55 indicating that students are better able to solve physics problems with the given theories and solve existing problems verbally. Even so, students' figural creativity also increased by 0.53% which showed that they could develop ideas to solve physics problems that require a systematic picture in them, this is in line with what was stated by Walia (2019) where creative actions lead to ideas original ideas and come up with possible options, but most importantly, it seeks to address imbalances. Meanwhile, the creative process leads to success in implementing ideas that solve problems. Figurally, students can provide various forms of images as a solution to solving existing problems. The drawings are arranged systematically and sequentially even though some concepts are still being repeated.

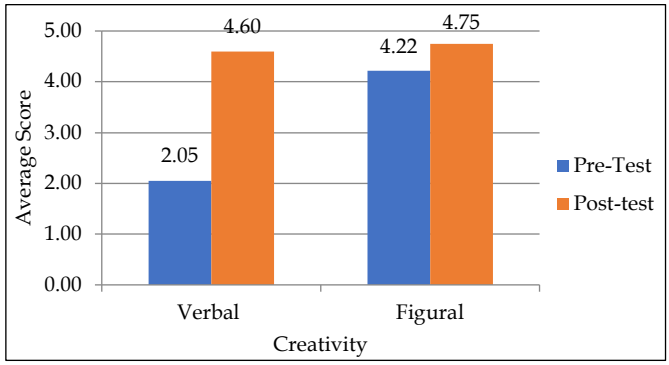

Figure 1. Average Scores of Pre-Test and Post-Test of Creativity

The N-gain recapitulation results of 82.07% on the total score of students' creativity calculations indicate that the increase in students' creativity is in the high category. This shows that the learning model applied is successful in increasing students' verbal and figural creativity in physics material. The increase experienced can be seen from the N-gain score obtained. Based on the table, the increase in verbal creativity increased by a score of 31.72% while figural creativity increased by 8.79% as shown in Figure 2.

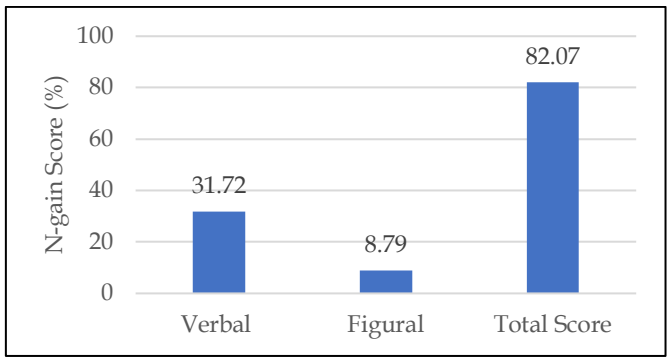

Figure 2. Comparison of Creativity N-gain Scores

In Figure 2 it can be seen that the increase in students' verbal creativity has increased better than the figurative one. This is indicated by the difference in scores of about 10% in the percentage of N-gain

obtained. In general, the increase in student creativity increased by 80% which is included in the high category.

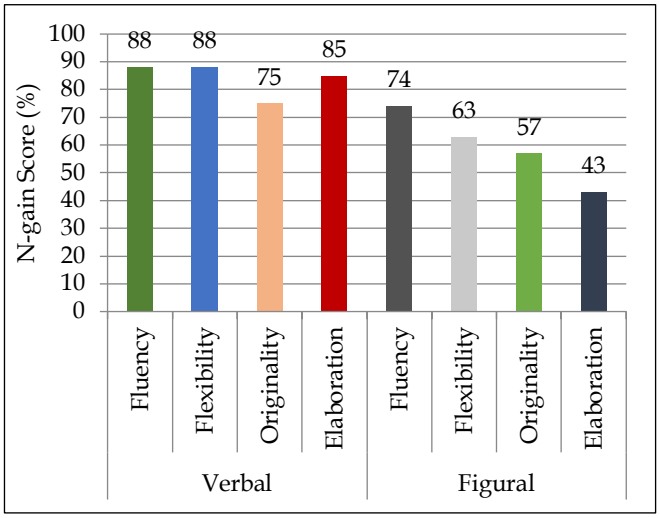

Figure 3. Comparison of N-Gain Scores on Each Creativity Indicator

Based on Figure 3, it is known that students' verbal abilities are better than their figurative ones. In addition, the fluency component obtained the highest score of 90% for verbal and figural creativity. Fluency shows the fluency of students in explaining each answer even though they only convey answers without knowing which ones are the same and which are not. Someone who thinks up ideas through creative thinking will indirectly improve cognitive learning outcomes (Siburian et al., 2019).

In addition, creativity is also closely related to higher-order thinking skills such as critical thinking skills. In inquiry learning, students are facilitated to develop their thinking skills so they can find new ideas or solve problems (Akpur, 2020). In general, students are very able to convey answers smoothly even though they do not know whether the answers match the questions at hand. In addition, students' flexibility abilities verbally are better than figuratively. This shows that they can differentiate each answer verbally so that they can answer questions more creatively. However, the difference in these scores is not significant, so it can be concluded that students are also able to provide ideas in different figural forms and according to the questions. The highest score obtained from the creativity indicator is the elaboration indicator on verbal abilities. Elaboration shows students' ability to develop previously written ideas into a more structured and detailed form. In learning creativity, students are not passive consumers of information but are active agents to create something new. This can be a new thing not only for students but for educators too (Jahnke & Liebscher, 2020). The development of creativity during learning is directed at stimulating children's abilities, creating new combinations, the ability to generate unusual responses, and encouraging children to think (Saguni, 2019).

Inversely proportional to the elaboration score on student figural creativity. This indicator gets the lowest score compared to other creativity indicators. This shows that students are quite capable of elaborating on each existing image but are not good enough to provide the appropriate details. However, overall, the N-gain category obtained by each indicator is in the medium and high categories.

Learning that is planned creatively will able to change the character to be more positive, and increase creative motivation such as a high sense of interest, initiative, and curiosity. During learning, students actively participate in exploring problems and then look for unique ideas to solve these problems (Kim et al., 2019). Learning by practicing creativity to solve problems will increase the ability to generate new ideas and truly creative problem solutions accompanied by active involvement in a group (Puccio et al., 2020). In addition, the elaboration of learning models such as the use of inquiry-based laboratory modules with experimental activities can promote cognitive achievement and emphasize creativity in science education. Model elaboration attracts interest to develop creative scientific ideas to be able to support experiments (Mierdel & Bogner, 2019). Learning design by involving students in asking questions, inquiry, investigating, risk-taking, innovation, divergent and convergent thinking, and metacognition will help the development process. The design implemented in the classroom will foster creativity among students (Yang et al., 2020).

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 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 student creativity. Based on data analysis, it was found that the pretest average value for the creativity instrument was 62.71 and the posttest average value was 93.50. This value was then analyzed using the N-gain test with an average calculation result of 82.07%, which means that this value is classified into the high improvement category so that the development of inquiry-based teaching materials is effectively used to increase student creativity.

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DEVELOPMENT OF INQUIRY-BASED TEACHING MATERIALS TO IMPROVE THE CREATIVITY OF PROSPECTIVE PHYSICS TEACHERS

Lovy Herayanti [1], Habibi[2], Baiq Azmi Sukroyanti[3*]
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Abstract. This research is part of development research at the development stage. Inquiry-based teaching materials developed to increase the creativity of physics teacher candidates have been validated by experts and declared fit for use. At this stage, the aim is to determine the effectiveness of the developed teaching materials in increasing the creativity of prospective physics teachers. The effectiveness of teaching materials developed by researchers can be known by increasing students' creativity based on the results of the N-Gain test after being given a pretest and posttest. The creativity instrument used is a description test which is divided into verbal and figural creativity tests. The pretest average score for the verbal and figural creativity instruments was 62.71 and the posttest average score for creativity was 93.50 both verbal and visual. This value was then analyzed using the N-Gain test with a calculation result of 82.07%, 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 the creativity of prospective physics teachers is valid and effective.

Keywords: teaching material, inquiry, creativity.

Introduction

Education has an important role in facing world competition. In "Essential 21st Century Skills" requires humans to learn faster and more precisely according to today's technology. Greenstein (2012) explained that students living in the 21st century must master the 4C skills (Critical Thinking, Communication, Collaboration, and Creativity). The demand for "Essential 21st Century Skills" is an ability that must be possessed by current students as a provision to become qualified individuals to face world competition. Through the 2013 curriculum, the government accommodates students with student-centered learning to meet the demands of the 21st century, one of the demands of the 21st century is creativity.

Creativity is the ability to create new ideas as a solution to a problem (Munandar, 2014). Creative learning outcomes are a form of complex cognitive ability. In science learning creativity is related to learning motivation. Thus, educators as facilitators must have creative pedagogical skills, both teaching creatively and teaching creativity in science (Conradty & Bogner, 2019). The ability to collaborate and creativity is an important concern for the development of capabilities in this century. Creativity developed through collaborative learning is an effective way of impacting the ability to think in different ways and generate new ideas (Gündoğdu, & Ali, 2022). Creativity is also a key ability not only for success but also for survival. Thus to build a creative personality needs to be done by using learning strategies, techniques and media that require a creative process. Because indirectly creative habits will be formed (Boronat & Choueiry, 2022).

Creativity can be developed through inquiry-based learning by doing projects in small groups. Students' creativity can be honed while working in cooperative teams to define relevant and original questions, formulate hypotheses, plan and analyze data to answer questions, discuss results, and then communicate these results to a wider group (Rodríguez et al., 2019). During learning, creativity requires a safe environment that offers space for self-regulation and self-responsibility to support self-development so that it will form a good learning atmosphere (Conradty & Bogner, 2020). Self-regulation and learning to be responsible for themselves during learning will help students to practice their creativity (Suyidno et al., 2019). Educators need to understand the various types and phases of inquiry so that students are ready to face the dynamics of education in the 21st century (Susanti et al., 2022). The guided inquiry learning model is an inquiry-based learning model in which students seek answers to the problems they face themselves (Nurmayani et al, 2018). The inquiry learning model can direct students to realize what they have got during the learning process. Investigation and analysis abilities carried out by students are the core of the inquiry learning model.

The inquiry learning model was chosen because it fulfills the procedure category in learning, which is closely related to science process skills (Yulkifli et al, 2020). As in the 2013 curriculum, learning materials consist of facts, concepts, principles, and procedures. 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 et al., 2019).

Basic Physics is one of the compulsory subjects for physics students at LPTK. This course is given in the first semester because it is a requirement for subsequent courses. Abstract physics concepts make teachers experience difficulties in conveying the concepts to be taught to students. This is in line with the statement of Kusdiastuti et al (2016) that the characteristics of some abstract concepts in physics cause difficulties in their visualization and delivery to students. Therefore, as a teacher, it is necessary to use various types of learning methods and models that can facilitate students in obtaining good knowledge and then developing their creativity.

Method

This research is part of Research and Development. The development model used in this study is the 4D model (Define, Design, Develop, and Disseminate) developed by Thiagarajan (1974). This research is one of the stages of the development stage, namely developmental testing. This research was conducted at one of the universities in Mataram. The chosen sample consists of 30 first-semester students from the Basic Physics course. A quasi-experimental research design with a pre-test and post-test design was used at this stage. The learning tools and instruments used have been validated by three experts and declared valid for use in the trial phase. The creativity instrument used is in the form of a description test which is divided into verbal and figural creativity tests. Increasing the creativity and 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 Cheng et al (2004) as shown in Table 1.

Table 1. N-Gain Score Classification

Range	Conversion in percent	Category
g < 0,3	g < 30	Low
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Result and Discussion

Creativity is essential for innovation and novelty. In creativity research in education, teachers must apply through learning with the right design (Kaplan, 2019). Creative results are not only new but must also be unique, appropriate to a particular task, and meaningful. Creativity can contribute to the development and cultivation of values that lead to meaningful, peaceful, sustainable, and wise lives (Glaveanu et al., 2020). If education is to determine better creativity practices in schools, then it is important to consider what kinds of tasks or creative thinking might be necessary for a given context and useful (Henriksen et al., 2020). People with good creativity will be able to come up with new ideas and then influence their surroundings to create new standards as well (Byrge & Gómez, 2019). Creativity also means all the unique productive endeavors of the individual. So, the world of creative education is very important in understanding a lesson or the meaning of all the activities carried out (Lian et al., 2020). In this decade, creativity has become a major requirement for developing all complex living systems to become increasingly digital. While teachers and education policymakers regard creativity as an important learning goal, it is important to develop these skills in the school environment (Vincent-Lancrin et al., 2019).

In this study, in developing the creativity of physics teacher candidates, teaching materials based on the inquiry model were developed. The inquiry model is one of the superior cognitive models for learning science in schools. Inquiry is considered to be quite effective in learning science and scientific skills. Inquiry is a learning strategy that can be used to teach students how to think (Arends, 2012). Chiappetta & Cobalt (2010) state that inquiry is a word used in the science education literature to characterize a process that is actively involved in scientific thinking, investigating, and constructing knowledge. In other words, an inquiry is a process of solving a problem with scientific activities. So that the learning becomes meaningful and memorable (Sutiani, 2021). Inquiry generally involves emotions so that scientific procedure activities can be directed and able to answer curiosity (Sulistiyono, 2020). Through investigative activities involving scientific procedures, it is hoped that it can help develop the creativity of students.

This research produces products that have been developed in the form of inquiry-based teaching materials, SAP or lecture program units, and LKM or student worksheets related to creativity that have been

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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.

Based on Table 2 below, it can be seen that students' initial abilities related to verbal creativity and figural creativity are different. This can be caused by the initial ability of students who prefer concepts that are related to figural. After learning to use the learning model used it is known that the verbal and figural abilities of students have increased. The increase experienced can be seen from the N-gain score obtained. Based on the table, the increase in verbal creativity increased by 31.72% while figural creativity increased by 8.79%. Based on these scores, it can be concluded that the creativity of students, especially verbal, increased more than their figurative creativity. This is caused by the applied model indicators. The learning model used provides opportunities for students to freely convey their creative ideas. They are given directions in correcting any wrong concepts, either verbally or figuratively. They are also allowed to solve existing problems by broadly providing ideas and solutions without being limited by existing answers.

Table 2. Creativity Data in General

	Verbal Creativity	Figural Creativity	Total Score
Pre-Test	2.05	4.22	62.71
Post-Test	4.60	4.75	93.50
N-Gain	31.72%	8.79%	82.07%

Figure 1 shows an increase in the creativity of students after learning to use inquiry learning. The difference in scores on verbal skills is quite large, which is equal to 2.55 indicating that students are better able to solve physics problems with the given theories and solve existing problems verbally. Even so, students' figural creativity also increased by 0.53% which showed that they could develop ideas to solve physics problems that require a systematic picture in them, this is in line with what was stated by Walia (2019) where creative actions lead to ideas original ideas and come up with possible options, but most importantly, it seeks to address imbalances. Meanwhile, the creative process leads to success in implementing ideas that solve problems. Figurally, students can provide various forms of images as a solution to solving existing problems. The drawings are arranged systematically and sequentially even though some concepts are still being repeated.

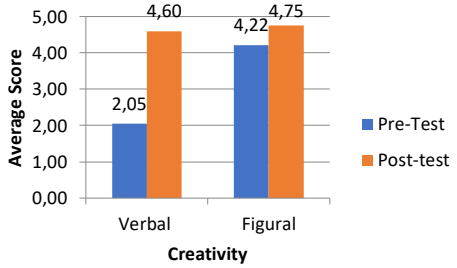

Figure 1. Average Scores of Pre-Test and Post-Test of Creativity

The N-gain recapitulation results of 82.07% on the total score of students' creativity calculations indicate that the increase in students' creativity is in the high category. This shows that the learning model applied is successful in increasing students' verbal and figural creativity in physics material. The increase experienced can be seen from the N-gain score obtained. Based on the table, the increase in verbal creativity increased by a score of 31.72% while figural creativity increased by 8.79% as shown in Figure 2.

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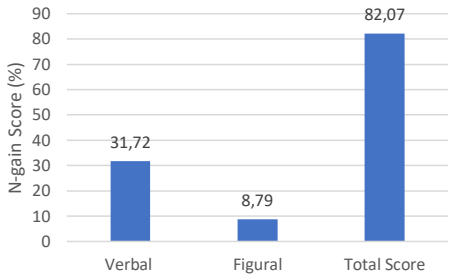

Figure 2. Comparison of Creativity N-gain Scores

In Figure 2 it can be seen that the increase in students' verbal creativity has increased better than the figurative one. This is indicated by the difference in scores of about 10% in the percentage of N-gain obtained. In general, the increase in student creativity increased by 80% which is included in the high category.

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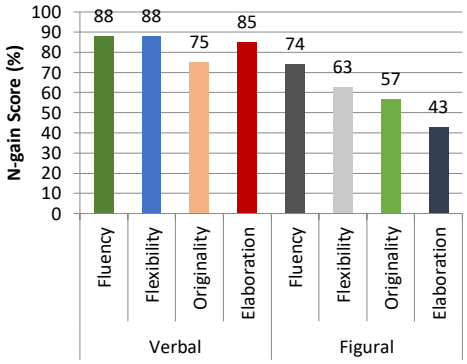

Figure 3. Comparison of N-Gain Scores on Each Creativity Indicator

Based on Figure 3, it is known that students' verbal abilities are better than their figurative ones. In addition, the fluency component obtained the highest score of 90% for verbal and figural creativity. Fluency shows the fluency of students in explaining each answer even though they only convey answers without knowing which ones are the same and which are not. Someone who thinks up ideas through creative thinking will indirectly improve cognitive learning outcomes (Siburian et al., 2019).

In addition, creativity is also closely related to higher-order thinking skills such as critical thinking skills. In inquiry learning, students are facilitated to develop their thinking skills so they can find new ideas or solve problems (Akpur, 2020). In general, students are very able to convey answers smoothly even though they do not know whether the answers match the questions at hand. In addition, students' flexibility abilities verbally are better than figuratively. This shows that they can differentiate each answer verbally so that they can answer questions more creatively. However, the difference in these scores is not significant, so it can be concluded that students are also able to provide ideas in different figural forms and according to the questions. The highest score obtained from the creativity indicator is the elaboration indicator on verbal abilities. Elaboration shows students' ability to develop previously written ideas into a more structured and detailed form. In learning creativity, students are not passive consumers of information but are active agents to create something new. This can be a new thing not only for students but for educators too (Jahnke & Liebscher, 2020). The development of creativity during learning is directed at stimulating children's abilities, creating new combinations, the ability to generate unusual responses, and encouraging children to think (Saguni, 2019).

Inversely proportional to the elaboration score on student figural creativity. This indicator gets the lowest score compared to other creativity indicators. This shows that students are quite capable of elaborating on each existing image but are not good enough to provide the appropriate details. However, overall, the N-gain category obtained by each indicator is in the medium and high categories.

Learning that is planned creatively will able to change the character to be more positive, and increase creative motivation such as a high sense of interest, initiative, and curiosity. During learning, students actively participate in exploring problems and then look for unique ideas to solve these problems (Kim et al., 2019). Learning by practicing creativity to solve problems will increase the ability to generate new ideas and truly creative problem solutions accompanied by active involvement in a group (Puccio et al., 2020). In addition, the elaboration of learning models such as the use of inquiry-based laboratory modules with experimental activities can promote cognitive achievement and emphasize creativity in science education. Model elaboration attracts interest to develop creative scientific ideas to be able to support experiments (Mierdel & Bogner, 2019). Learning design by involving students in asking questions, inquiry, investigating, risk-taking, innovation, divergent and convergent thinking, and metacognition will help the development process. The design implemented in the classroom will foster creativity among students (Yang et al., 2020).

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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 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 student creativity. Based on data analysis, it was found that the pretest average value for the creativity instrument was 62.71 and the posttest average value was 93.50. This value was then analyzed using the N-gain test with an average calculation result of 82.07%, which means that this value is classified into the high improvement category so that the development of inquiry-based teaching materials is effectively used to increase student creativity.

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is hoped that it can help develop the creativity of students.

This research produces products that have been developed in the form of inquiry-based teaching materials, SAP or lecture program units, and LKM or student worksheets related to creativity that 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.

Based on Table 2 below, it can be seen that students' initial abilities related to verbal creativity and figural creativity are different. This can be caused by the initial ability of students who prefer concepts that are related to figural. After learning to use the learning model used it is known that the verbal and figural abilities of students have increased. The increase experienced can be seen from the N-gain score obtained. Based on the table, the increase in verbal creativity increased by 31.72% while figural creativity increased by 8.79%. Based on these scores, it can be concluded that the creativity of students, especially verbal, increased more than their figurative creativity. This is caused by the applied model indicators. The learning model used provides opportunities for students to freely convey their creative ideas. They are given directions in correcting any wrong concepts, either verbally or figuratively. They are also allowed to solve existing problems by broadly providing ideas and solutions without being limited by existing answers.

Table 2. Creativity Data in General

	Verbal Creativity	Figural Creativity	Total Score
Pre-Test	2.05	4.22	62.71
Post-Test	4.60	4.75	93.50
N-Gain	31.72%	8.79%	82.07%

Figure 1 shows an increase in the creativity of students after learning to use inquiry learning. The difference in scores on verbal skills is quite large, which is equal to 2.55 indicating that students are better able to solve physics problems with the given theories and solve existing problems verbally. Even so, students' figural creativity also increased by 0.53% which showed that they could develop ideas to solve physics problems that require a systematic picture in them, this is in line with what was stated by Walia (2019) where creative actions lead to ideas original ideas and come up with possible options, but most importantly, it seeks to address imbalances. Meanwhile, the creative process leads to success in implementing ideas that solve problems. Figurally, students can provide various forms of images as a solution to solving existing problems. The drawings are arranged systematically and sequentially even though some concepts are still being repeated.

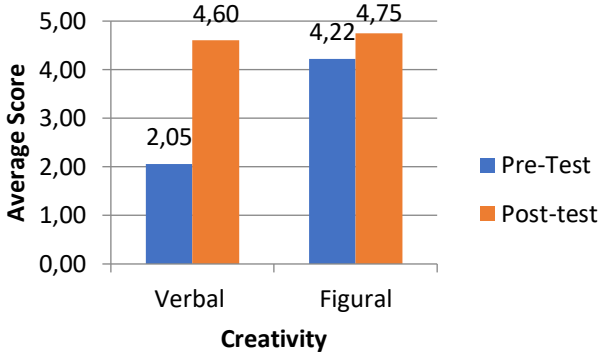

Figure 1. Average Scores of Pre-Test and Post-Test of Creativity

The N-gain recapitulation results of 82.07% on the total score of students' creativity calculations indicate that the increase in students' creativity is in the high category. This shows that the learning model applied is successful in increasing students' verbal and figural creativity in physics material. The increase experienced can be seen from the N-gain score obtained. Based on the table, the increase in verbal creativity increased by a score of 31.72% while figural creativity increased by 8.79% as shown in Figure 2.

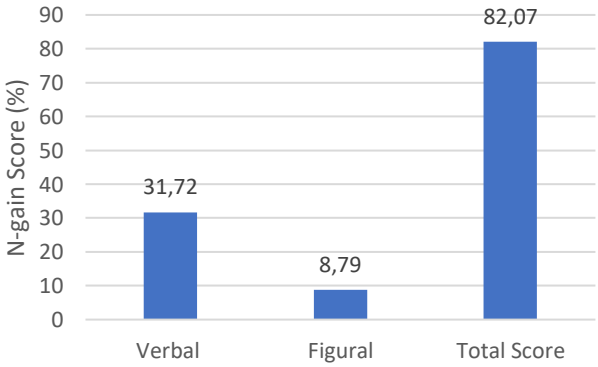

Figure 2. Comparison of Creativity N-gain Scores

In Figure 2 it can be seen that the increase in students' verbal creativity has increased better than the figurative one. This is indicated by the difference in scores of about 10% in the percentage of N-gain obtained. In general, the increase in student creativity increased by 80% which is included in the high category.

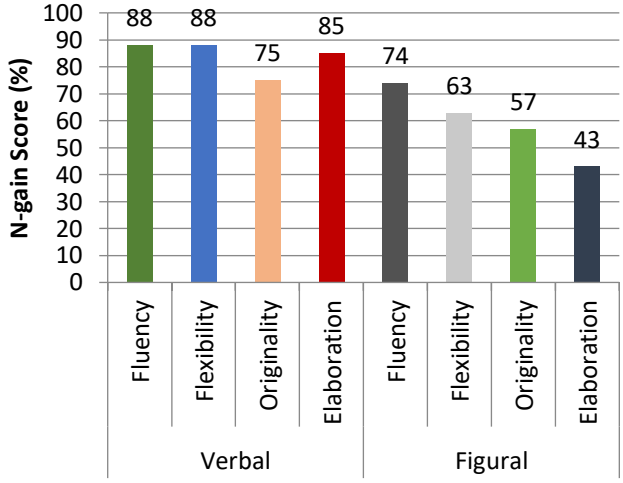

Figure 3. Comparison of N-Gain Scores on Each Creativity Indicator

Based on Figure 3, it is known that students' verbal abilities are better than their figurative ones. In addition, the fluency component obtained the highest score of 90% for verbal and figural creativity. Fluency shows the fluency of students in explaining each answer even though they only convey answers without knowing which ones are the same and which are not. Someone who thinks up ideas through creative thinking will indirectly improve cognitive learning outcomes (Siburian et al., 2019).

In addition, creativity is also closely related to higher-order thinking skills such as critical thinking skills. In inquiry learning, students are facilitated to develop their thinking skills so they can find new ideas or solve problems (Akpur, 2020). In general, students are very able to convey answers smoothly even though they do not know whether the answers match the questions at hand. In addition, students' flexibility abilities verbally are better than figuratively. This shows that they can differentiate each answer verbally so that they can answer questions more creatively. However, the difference in these scores is not significant, so it can be concluded that students are also able to provide ideas in different figural forms and according to the questions. The highest score obtained from the creativity indicator is the elaboration indicator on verbal abilities. Elaboration shows students' ability to develop previously written ideas into a more structured and detailed form. In learning creativity, students are not passive consumers of information but are active agents to create something new. This can be a new thing not only for students but for educators too (Jahnke & Liebscher, 2020). The development of creativity during learning is directed at stimulating children's abilities, creating new combinations, the ability to generate unusual responses, and encouraging children to think (Saguni, 2019).

Inversely proportional to the elaboration score on student figural creativity. This indicator gets the lowest score compared to other creativity indicators. This shows that students are quite capable of elaborating on each existing image but are not good enough to provide the appropriate details. However, overall, the N-gain category obtained by each indicator is in the medium and high categories.

Learning that is planned creatively will able to change the character to be more positive, and increase creative motivation such as a high sense of interest, initiative, and curiosity. During learning, students actively participate in exploring problems and then look for unique ideas to solve these problems (Kim et al., 2019). Learning by practicing creativity to solve problems will increase the ability to generate new ideas and truly creative problem solutions accompanied by active involvement in a group (Puccio et al., 2020). In addition, the elaboration of learning models such as the use of inquiry-based laboratory modules with experimental activities can promote cognitive achievement and emphasize creativity in science education. Model elaboration attracts interest to develop creative scientific ideas to be able to support experiments (Mierdel & Bogner, 2019). Learning design by involving students in asking questions, inquiry, investigating, risk-taking, innovation, divergent and convergent thinking, and metacognition will help the development process. The design implemented in the classroom will foster creativity among students (Yang et al., 2020).

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 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 student creativity. Based on data analysis, it was found that the pretest average value for the creativity instrument was 62.71 and the posttest average value was 93.50. This value was then analyzed using the N-gain test with an average calculation result of 82.07%, which means that this value is classified into the high improvement category so that the development of inquiry-based teaching materials is effectively used to increase student creativity.

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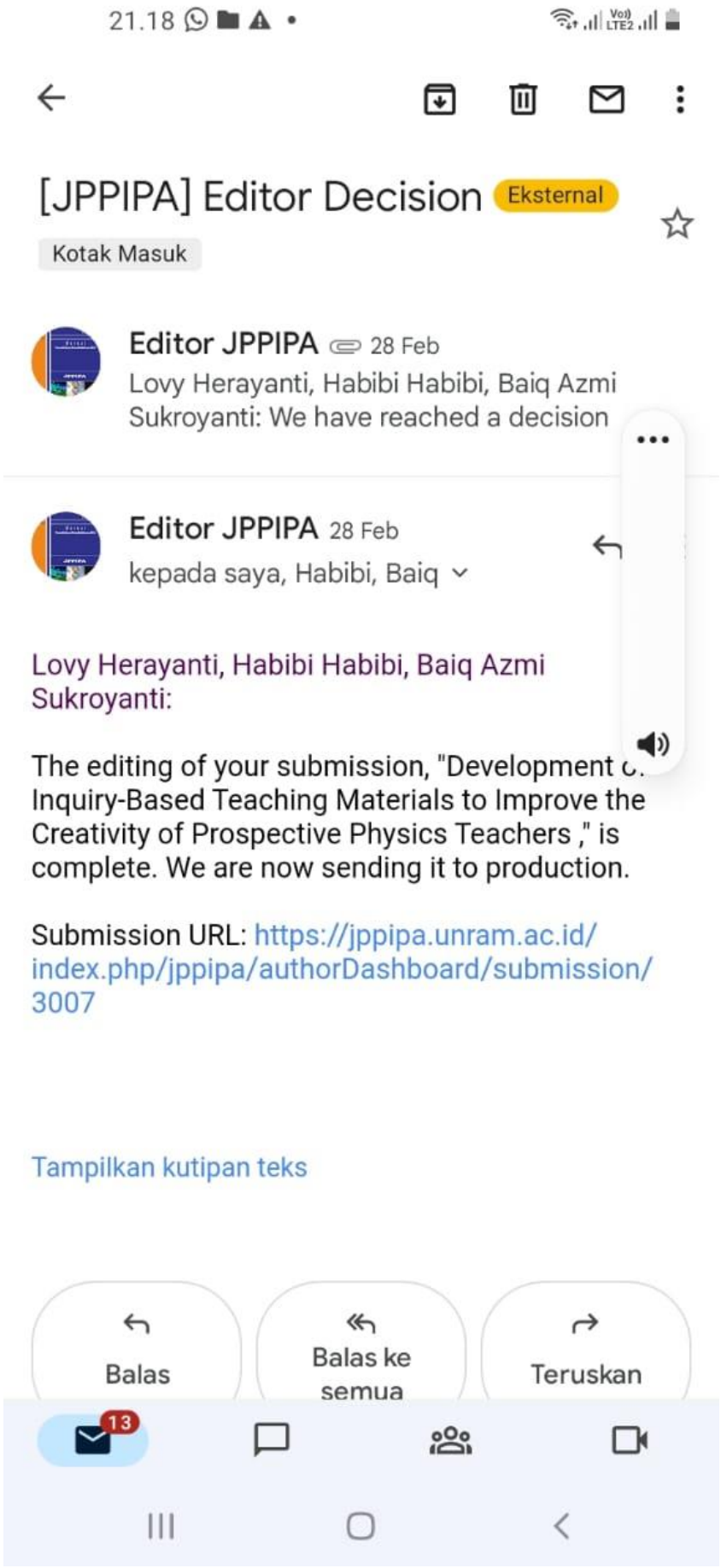
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[JPPIPA] Editor Decision
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