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# THE DEVELOPMENT OF SCIENCE LEARNING DEVICE BASED ON INTERCONNECTED INTEGRATION IN INCREASING CRITICAL AND CREATIVE THINKING OF STUDENTS'

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## Abstract

*Interconnected Integration based learning is really needed to narrow the dualism space or the science dichotomy which separates between general education and religion education which then has an impact on the separation and segregation of religious awareness and general science. In the learning process, critical and creative thinking skills are very important, because it can make people become more mentally flexible, open and easy to adapt to various situations and problems. The type of this research was research and development (R & D). The development model used in this study was a modification of Borg and Gall's development stage which states that there were 10 stages in research and development. The research results showed that the instructional materials produced had very good validity (89%), very practical (91.19% by teachers and 86.21% by students and very efficient with the average critical and creative thinking (pretest) of students; 66.31 and posttest 80.26, and the results of the t-test count = 15.712 with sig 0.00 <0.05. This shows that there were significant differences before being treated and after treated by using the interconnection approach in improving students' critical and creative thinking.*

**Keywords:** *Integration; Interconnection; Critical Thinking; Creative Thinking; Science Learning.*

## A. Introduction

According to Law Number 20 of 2003, national education has functions to develop skills and shape of dignified national character and civilization in order to educate the lives of the nation. Then, it is also aimed to develop the potential of students to be faithful and devoted to God Almighty, noble, healthy, skilled, creative, independent, and a democratic and responsible citizen (Depdiknas, 2013:5).

Education at this time should be able to form students who can face the era of globalization, environmental problems, advances in information technology, the convergence of science and technology, knowledge-based economies, the rise of creative industries and culture, shifting world economic power, and the influence and impact of science-based technology. In the Minister of Education and Culture Regulation Number 65 of 2013 concerning Process Standards, it is stated that the standard learning process in 2013 Curriculum uses learning with an integrated scientific, thematic, and thematic approach. The choice of this learning approach is seen as being able to achieve educational goals namely the balance of knowledge, attitudes, and skills in students (Hilda, 2015: 72).

Science and religion are inseparable sciences, even it is said that science without religion is paralyzed, and religion without science is blind. That is how Einstein looked at the two fields that could not be separated. In this case, there is a need for a new paradigm in building Islamic civilization by Islamizing science based on monotheism (Wan Sabri, 2015; 51). Therefore, science is tied to value and it is not free as produced by western civilization (Naquib, 1993: 134).

The world of education is always changing and it requires students who can increase knowledge, develop higher-order, thinking skills, such as systems of critical thinking, decision making, and problem-solving. There were a number of significant changes in the past few decades in the field of education, which previously the teacher was the center of learning, while today's education involves teaching ways of thinking, and in particular, how to become critical thinkers. Critical thinking has been investigated, especially in terms of thinking skills that involve the cognitive domain (Aizikovitsh-Udi and Amit, 2011: 1088).

Koballa and Chiappetta define science as a way of thinking, a way of investigating, a body of knowledge, and its interaction with technology and society. It can be summarized that in the natural sciences there are dimensions of ways of thinking, ways of investigation, the building of knowledge and its relation to technology and society. This has become a fundamental substance of the importance of science learning that develops scientific processes for the formation of students' mindsets (2010: 105).

Learning science at the level of Madrasah Tsanawiyah (MTs)/ SMP is an integrated science which is a teaching and learning approach that involves several fields of study to provide meaningful experiences to students. With this integrated education, children will understand the concepts that they learn through direct observation and connect with other concepts that they understand. Integrated learning can be started with a specific topic or theme which is then related to other subjects through good planning, so it creates more meaningful learning. Integrated science learning is a science learning model that packs the whole science including biology, physics, and chemistry. In integrated science learning, a theme is discussed from the point of view of study including biology, physics, and chemistry, so that students can study the science as a whole from a theme (Rahayu, et.al., 2012).

The education system that is needed now is an education system based on the values of faith and *taqwa* and it is time to leave the education system that has been practiced in a long time which tends to be semi-secular. Faith and *taqwa* based learning is a learning process in which all subjects are based on the treasures of universal values derived from religion as a source of comprehensive *ilahiyah* values with the establishment of school culture in all educational environments/ institutions which are religious, educative and scientific.

This is in line with the results of research conducted by Yati Komalasari in Winarti which states that lesson plan (RPP), LKS, and interconnected integration rules with the Islamic paradigm can stimulate students to become active and cooperative in the classroom, as well as able to comprehend the

material thoroughly (Winarti, 2015). This learning tool is an absolute thing that must be prepared by the teacher in starting the learning process.

Critical thinking will enrich creativity and improve the ways to use and manage time and not only describing thinking skills in accordance with the rules of logic and probability but also the ability to apply skills to be real (Idris, et.al., 2018: 8226–8230). Critical thinking can give a deeper understanding of a person and provide opportunities to be objective, less emotional, and more open-minded when respecting the views and opinions of others. By thinking ahead, the students will gain the confidence to present new perspectives and new insights into the problem that they face (Karakoc, 2016:81).

The ability of critical thinking is an intellectual capital that is very important for students. Every student has the potential to grow and to become a critical thinker because thinking activities are related to the pattern of self-organization that every person has (Liliasari, 2001).

The ability to think critically and creatively is the ability that students must have to be able to face change, to become innovative and competitive (Achinike & Ogbonna, 2016). This must be built from an early age to produce superior human beings who become hopes for the country and can uphold religion in their lives. A student who thinks critically is expected to be able to analyze ideas in a more specific direction, distinguish things sharply, choose, identify, study, and develop in a more perfect direction. However, creative thinking is a mental activity that produces something new as a result of development.

The ability of critical thinking is one of the high level thinking abilities in which someone who is able to think critically, not only solves problems, but he or she is also able to provide reasonable reasons for the solutions given because basically thinking is an activity that is done to reach a conclusion (Yuliani dan Saragih, 2015: 118).

Most teachers and researchers agree that an important aspect of critical thinking is the ability to collect, evaluate and utilize information effectively and appropriately. Critical thinking emphasizes the metacognitive element of critical thinking, through the reason that it can

be defined as thinking about thinking while thinking to make better thinking (Iakovos, 2011: 82).

The results of Winarti's research (2015) when the concept of physics is associated with the verses of the Qur'an in learning are students feel interested because of getting new things that have never been obtained before. Based on the field test, it was found that students were very enthusiastic about learning and became even more curious about other physical concepts that could be related to the verses of the Qur'an. This is in line with the opinion expressed by the teacher during the interview that students will be very interested if there is a value of verse and Islamic values in physics learning. This causes the learning process to be more alive and students' learning motivation can increase.

Interconnected integration in the learning process is a filter that will defend students in facing globalization that has a negative impact. Through the religious values that are implied continuously in learning, it will increase the values of monotheism in students so that character formation is expected to be achieved. To be able to face globalization and the competition that we now know as the Asean Economic Community (AEC), the education must be able to create humans who think critically and creatively.

An interconnected integration approach is an approach that tries to relate general science and religion because they have limitations in solving human problems, so this will create collaboration i.e. understanding each other's approach and the method of thinking (process and procedure) between the two sciences (Abdullah, 2008: 242).

Students who think critically and creatively are the efforts of teachers informing and preparing them early. The approaches, methods, strategies, and learning the media must be chosen appropriately to achieve the desired goals. The contextual approach, scientific method, inquiry, problem-solving and others are the teachers' efforts in creating interesting and easy to understand learning. To answer those problems above, the researcher was interested in researching with the title Development of Science Learning Devices Based on Interconnected Integration in Improving the Critical and Creative Thinking Ability of Students in MTsN of Padangsidimpuan City.

## B. Method

### 1. Type of Research

The type of this research is research and development(R & D). The development model used in this study was a modification of Borg and Gall's development stage which states that there were 10 stages in research and development, namely (1) collecting information and preliminary research; (2) conducting research planning; (3) developing the initial product form; (4) conducting a limited trial of the initial product to produce the main product (Preliminary field test); (5) revising the main product; (6) conducting a trial of the main product (Main test); (7) revising the main product to produce the final product; (8) conducting a field trial of final product (operational field test); (9) revising the final product; (10) disseminating and implementing products (Borg and Gall, 1983; 775).

### 2. Sources of Data

a. Experts in the field of natural sciences, interconnected integration experts, media experts, linguists.
b. Students and science teacher of MTsN in Padangsidimpuan City.

### 3. Research Instrument

The instrument used in this study consisted of:

a. Modules validation sheets and the test of critical and creative thinking ability, to determine the level of validity of learning devices tools that are developed.
b. A questionnaire to determine students' responses to the use of learning devices and to measure the validity of learning devices by experts.
c. A test to measure students' critical and creative thinking skills

#### 1) Development Procedures

The development procedure carried out in this study was adapted from the development model according to Borg and Gall. This study followed the modification of Sukmadinata's research. The written steps of Borg and Gall research and development that were stated in three steps,

namely preliminary study, product development, and product testing. The following is a description of each stage (2006:184).

**a) Preliminary Study Stage**

This stage was the preparation stage for development. This stage included a literature study, field survey, and product drafting (Sukmadinata, 2006:184). The literature study was carried out by collecting information related to the development of learning devices based on the K13 Curriculum. This information included the curriculum used in MTsN of Padangsidimpuan City and the characteristics of the students of MTsN. The field survey was conducted to collect data in the form of modules used in MTsN, the approach used in science learning, and students' learning habits in both Ibtidaiyah Madrasah.

**b) Product Development Stage**

The main activity in this stage was the preparation of products in accordance with the draft (draft) so that they were ready to be tested. At this stage the initial product was produced, the learning device validation was carried out, and a revised product was produced. The following is a description of each stage of product development.

(1) The initial product was produced

The initial product was the product that has been made by the researcher based on the results of the analysis and design that has been carried out. At this stage the initial product learning devices that have been made by the team with several experts to get suggestions related to the development of learning tools. The initial product produced was in the form of textbooks in the form of modules in which the quality was still not assessed yet.

(2) Validation to experts of Modules quality assessors

After the initial product has been developed, product development validation was carried out by media experts, material experts, modules quality assessors which would then be used as a reference to make improvements to product

development. This assessment was carried out to determine the validity of the learning device.

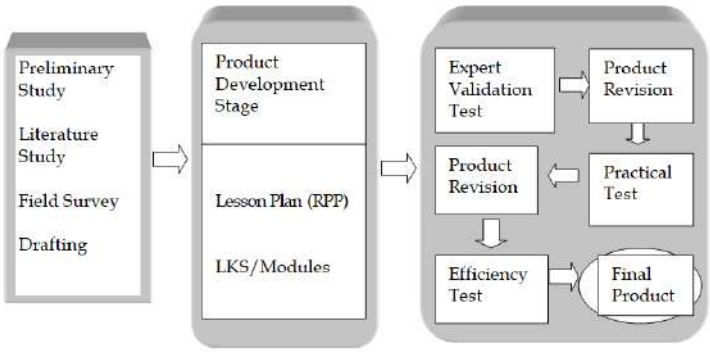
(3) Revised Product

The revision of learning devices based on assessment results was in the form of input and suggestions from the validation. If the development product had been revised and declared feasible, the product was ready to be tested.

**c) Product Testing Stage**

After going through the development stage and according to the results of the assessment of experts and practitioners, the learning devices had have been declared valid then the learning device was ready to be tested in class. The development product was tested on MTsN students to see the improvement of students' critical and creative thinking. After going through the trial phase, an analysis of the practicality and effectiveness of the learning device was carried out, as well as product revisions based on the results of the student response questionnaire data analysis and the suggestions given by the students during the trial.

*Figure 1: Development Chart*




## C. Finding and Discussion

### 1. Finding

**a. The Validity of Teaching Materials**

The functions of this validity are (1) to know whether the draft learning device that has been compiled valid or not based on the experts'

considerations or validation, (2) to know whether the valid learning device is practically used in the field of research, (3) to see whether a valid and practical device can achieve the results and determined objectives i.e. that is effective learning. The measurement is done twice; the first stage is after the FGD 1 discussion has been done, then the FGD 2 and the test is done in the classroom. The following are the results of the validation and revision of the learning device using an interconnected integration approach to improve students' critical and creative thinking skills.

*Table 1: The Validity of Product by Materials Expert*

| **Aspects** | **Validity (%)** | |
|---|---|---|
| | **I** | **II** |
| Concept correctness | 75 | 85 |
| Concept depth | 75 | 92 |
| Concept wideness | 80 | 90 |
| Implementation | 74 | 91 |
| Language | 75 | 87 |
| Mean | 75.2 | 89 |

*Figure 2: The Product Validity of Material Expert*

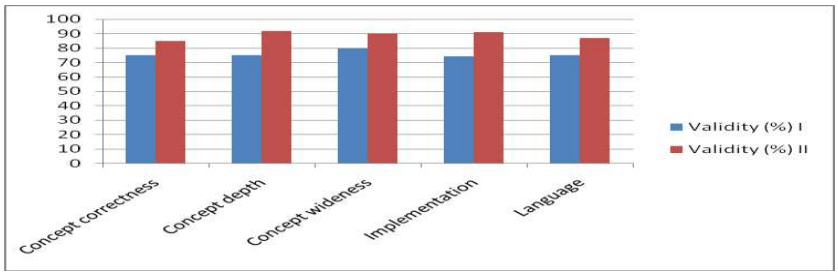



*Table 2: TheProduct Validity by Media Expert*

| **Aspects** | **Validity (%)** | |
|---|---|---|
| | **I** | **II** |
| Materials Anatomy | 75 | 91 |
| Materials Quality | 75 | 89 |
| Overall Layout | 70 | 90 |
| Mean | 73.33 | 90 |

*Figure 3: The Product Validity by Media Expert*


*Table 3: The Product Validity by Language Expert*

| Aspects | Validity | |
|---|---|---|
| | I | II |
| Readability | 75 | 85 |
| Information clarity | 70 | 87 |
| Conformity with good grammar | 76 | 89 |
| Making use of language effectively and efficiently | 70 | 89 |
| Mean | 72.75 | 87.5 |

*Figure 4: The Validity of Language Expert*

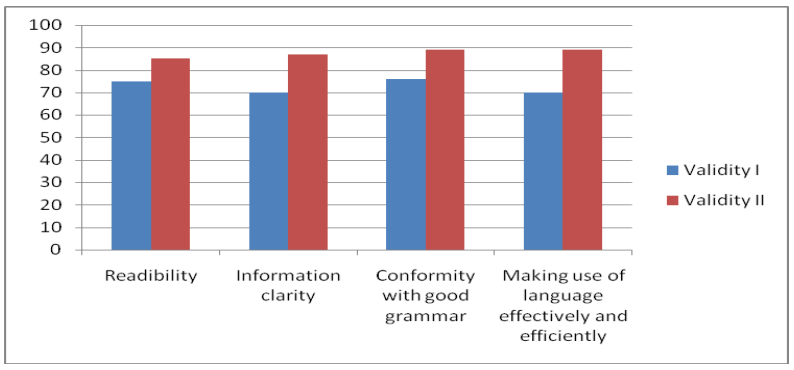
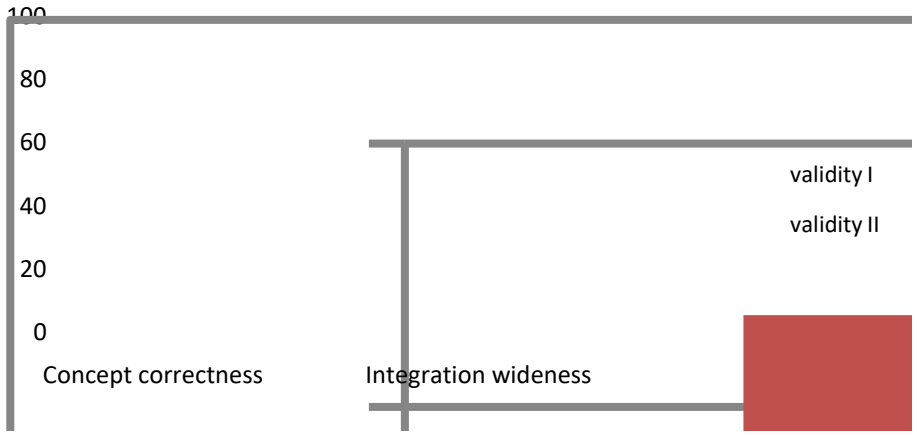


*Table 4: The Validity of Product by Integration Expert*

| Aspects | Validity (%) | |
|---|---|---|
| | I | II |
| Concept correctness | 70 | 87 |
| Interconnected integration | 72 | 88 |
| Integration wideness | 70 | 90 |
| Reflection | 75 | 91 |
| Mean | 71.75 | 89 |

*Figure 5: The Validity of Product by Integration Expert*




The results of product validity whether for material, media and language show that it is very valid and feasible to be used as teaching materials for integrated and connected science materials, with a validity level of 89%.

**b. The Practicality of Learning Development using Interconnected Integration Approach**

Teaching materials must fulfill the practical aspects of understanding and implementing the teaching materials. According to Mudjijo, one of these instruments can be easily implemented and interpreted as a result. Practicality shows the level of ease of use and implementation which includes the costs and time in the implementation and the management and interpretation of the results. Therefore, the

purpose of the practicality test is to know the extent of the ease and the implementation of learning development with the interconnected integration approach (Mudjijo, 1995: 59).

*Table 5. Practicality test of teaching material by science teacher*

| Aspects | Practicality (%) MTsN |
|---|---|
| Textbook content | 91.21 |
| Textbook Presentation | 91.88 |
| Textbook Benefits | 90.57 |
| Textbook Opportunity | 91.09 |
| Mean | 91,19 |

The result of a teacher's practicality on teaching materials indicates that teaching materials are categorized as very practical with an average of 91.19%. For more clearly, the values obtained by each indicator of the practicality of teaching materials covering textbook content, presentation in textbooks, the benefits of textbooks, textbook opportunities (Anggela, et.al., 2013: 67), can be seen in the graph below.

In detail, the result of the practicality test can be seen in Table 6 below.

*Table 6: Practicality Test*

| Aspects | Practicality (%) MTsN |
|---|---|
| Effectivity | 85.50 |
| Creativity | 87.32 |
| Efficience | 84.88 |
| Interactivity | 86.61 |
| Interest | 86.74 |
| Mean | **86.21** |

Based on the above practicality questionnaire analysis, the practicality value is 86.21% which is in a very practical category.

**c. Product Affectivity**

*Table 7: Descriptive Statistics*

| | N | Minimum | Maximum | Sum | Mean | Std. Deviation |
|---|---|---|---|---|---|---|
| x1 | 38 | 50.00 | 75.00 | 2520.00 | 66.3158 | 5.02483 |
| x2 | 38 | 70.00 | 85.00 | 3050.00 | 80.2632 | 4.78559 |
| Valid N (listwise) | 38 | | | | | |

x1= pretest
x2= postest

**Table 8: Paired Samples Test**

| | | Paired Differences | | | | | t | df | Sig. (2-tailed) |
|---|---|---|---|---|---|---|---|---|---|
| | | Mean | Std. Deviation | Std. Error Mean | 95% Confidence Interval of the Difference Lower | Upper | | | |
| Pair 1 | x2 - x1 | 13.94737 | 5.47203 | .88768 | 12.14876 | 15.74598 | 15.712 | 37 | .000 |

From the table, it is seen that the value of t count is 15.712 with sig 0.00 <0.05, which shows that the learning device using the interconnected integration approach increases more significantly than before using the learning device.

**2. Discussion**

The validity results of the material and language experts whether in the correctness of the concept, the depth of the concept, the breadth of the concept, the feasibility and linguistic, show a very satisfying value of 89%. Also, the same thing happens to the media anatomy experts showing that teaching material quality and overall appearance are 90%, linguists are 87.5% and integration expertise 89%. It means that there is an excellent

result in the integration and reflection produced by the teaching material. The validity results from the expert show very good results with an average of 88.87%, which means that it is suitable to use as integrated teaching materials and connected to science learning in the Solar System material.

A product that can be used according to its purpose requires validity testing. Validity is an assessment of the design of a product. According to Sugiyono (2011: 302), product validation can be done by several experts or experienced experts to assess the weaknesses and strengths of the products produced. Validation can be done by a team of experts in the development of teaching materials. The validity components according to the Ministry of National Education regarding the development of teaching materials and general criteria assessed by experts include the components of content feasibility, linguistic components, presentation components, and graphic components (Depdiknas, 2008: 27).

The test of content feasibility component is a test of the validity of content or material from a teaching material. This is in line with what is stated by the Ministry of National Education stating that "Components of content eligibility include: conformity with standard of competences and basic competences, conformity with child development, suitability with the needs of teaching materials, the correctness of the substance of learning material, benefits for additional insight, conformity with moral values, and values social". This Ministry of National Education's statement shows that the validity of a teaching material that is seen from the content of the material or its content must be in accordance with several analyzes such as standard of competences (SK) and basic competences (KD) analysis, needs, truth of substance, benefits, moral values and social values (Depdiknas, 2008: 27).

The second criterion for the validity component of the teaching material is seen from the linguistic aspect. The criteria regarding these linguistic aspects assess whether the information conveyed in the teaching material reaches the students well as readers. Furthermore, the Ministry of National Education explained that: "Linguistic components include: legibility, clarity of information, conformity with Indonesian rules that are a good and right, effective and efficient use of language (clear and concise)". If the

production of teaching materials focuses on the components of this linguistic criterion properly, the information conveyed will be given well.

In line with the Ministry of National Education, Sungkowo (2010:17) said that the components-making grid and the criteria that must be stated in the development of ICT-based teaching materials include 4 components, namely material substance, learning design, visual communication display, and software utilization. The following lines are designed based on criteria and components for assessing the validity of ICT-based teaching materials. This grid is then used to create validity instruments or validation sheets.

In addition to the validity of teaching materials, practicality is also tested, namely understanding and the implementation of the teaching materials. According to Mudjijo, one of these instruments can be easily implemented and interpreted as a result. Practicality shows the ease level of use and implementation which includes the costs and time in the implementation and the management and interpretation of the results. Therefore, the purpose of the practicality test is to find out how far the ease and feasibility of teaching materials can be used (Slameto, 2003:81).

The result of practicality by teachers is about 91.19% and students are 86.21% which indicates that teaching materials are very practical. However, the effectiveness test shows that the average critical and creative thinking (pretest) of students for MTsN is 66.31 and post testis 80.26, and the results of the t-test are 15.712 with sig 0.00 <0.05. This implies that there are significant differences between before being treated and after using the interconnected integration approach in improving students' critical and creative thinking.

Effectiveness is an important factor in learning. Effective learning is a match between students who carry out learning with the goals or objectives of learning to be achieved. Effectiveness is how a person succeeds in getting and utilizing learning methods to get good results. Chong and Maginson in Slameto (2003: 81) stated that effectiveness is a match between students and learning outcomes. Based on this opinion it can be said that the effectiveness of learning is a process that must be passed by students to achieve learning outcomes.

The most efficient strategy does not always become an effective strategy which means that if the goal is achieved, how far its effectiveness still has to be questioned. A way to measure this effectiveness is by determining the transferability (ability to move) the principles learned. If the goal can be achieved in a shorter time with a certain strategy than other strategies, then the strategy is efficient, if the ability to transfer information or skills that are learned is achieved more through a strategy rather than other strategies, then the strategy is effective for achieving learning objectives (Istarani, 2011: 78).

One of the problems in the world of education that still exists in Indonesia today is the dichotomy of science, namely the contradiction and separation between religious science and non-religious science, both in concept and practice. Both of these sciences are often regarded as two different entities and stand-alone and each that is not accessible to each other. The science of religion is considered sacred and must be studied because it comes from revelation. On the contrary, the social-science discipline does not need to be studied because it is the result of human thought (Rohman dan Wahyudin, 2017).

The existence of scientific dichotomy will affect the education model that is used. General sciences are only studied and developed in public schools or universities, while religious science is developed in madrasas, pesantren, and religious colleges. So the development of secular sciences runs as if uprooted from the moral and ethical values of human life, while the development of religious science only emphasizes normative Islamic texts so that it feels less able to answer the challenges of the times. This considerable distance then makes these two scientific fields experience an unhealthy growth process and have a negative impact on the growth and development of social, cultural, political and religious life in Indonesia (Abdullah, 2010).

The results obtained from various aspects that have been validated by the respective experts indicate that the instructional material produced is feasible to be used in improving students' critical and creative thinking. This is also a form of researcher's role and existence in improving education in Padangsidimpuan.

The results that are obtained must reflect the student's character on the majesty of God for His creation, gratitude for the blessings of God, and fear of the destruction of God's creation that will ground all earth and its contents. The character continues to be built from attitudes or actions that will continue to be reflected in students so that the attitude to do improper actions can be dammed and fortified from the faith created by the Divine values that are continuously expressed in the learning process.

Learning science is based on content standards that will not only create students who have knowledge (have a body of knowledge), standard processes that shape students who have scientific skills (scientific skills), thinking skills and thinking strategies (strategy of thinking); but it also contains scientific inquiry standards that will shape students who are able to think critically and creatively (critical and creative thinking); assessment standards that evaluate students in a humane way according to what students experience in learning (authentic assessment). The application of the standards in natural science learning, especially the four standards will provide soft skills in the form of students' character, for this reason, it is very necessary for science learning to apply standards to build students' character. Students with character can be characterized when students have the ability to integrate knowledge, skills, and attitudes in an effort to understand the environment (Widhy, 2013).

The 2013 curriculum stated that science learning at the SMP / MTs level is carried out on an integrated basis. Learning science is developed as an integrative science subject, not as a discipline education. Both areas applicative-oriented education, developing thinking skills, learning abilities, curiosity, and the development of caring and responsible attitudes to the natural and social environment. Integrative science has the meaning of integrating various aspects, namely the domain of attitudes, knowledge, and skills. Science teachers must also have an interdisciplinary ability in science that is shown in science (knowledge).

## D. Conclusion

Critical and creative thinking skills are abilities that students must have to be able to face change, innovate and be competitive. This must be

built early to produce superior human hopes of the state that upholds religion in the joints of their lives. A student who thinks critically is expected to be able to analyze ideas in a more specific direction, distinguish things sharply, choose, identify, study, and develop in a more perfect direction. While creative thinking is a mental activity that produces something new as a result of development. The research results showed that the instructional materials produced had very good validity 89%, very practical 91.19% by teachers and 86.21% by students. The efficient test showed that very efficient with the average critical and creative thinking pretest of students 66.31 and posttest 80.26.

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