HOTS - based scientific learning to increase the comprehension concept and science students skill

Dewi Widyaningrum\textsuperscript{1*}, Sri Utaminingsih\textsuperscript{1}, Santoso\textsuperscript{1}

\textsuperscript{1}Program Studi Magister Pendidikan Dasar, Universitas Muria Kudus
dewiwidyaningrum97@gmail.com

Abstract. This research aims to know the effectiveness of HOTS based scientific learning models to increase the comprehension concept and science students skill. The method was quasi-experiment with Pretest-Posttest Control Group Design. The type of data obtained in this study is quantitative data. Data collection techniques in this study were used observation, student questionnaires, and student evaluation tests. Data analysis using the homogeneity, normality, and t-test to test the effectiveness of the model. Based on the output table "independent samples test, it is known that the sig. (2-tailed) knowledge value is 0.224 and the sig (2-tailed) skill value is 0.507. Because the sig value is 0.224 and 0.507 > 0.05, according to the basis of decision making in the independent sample t-test, it can be concluded that Ho is accepted and Ha is rejected, which means that there is a difference between the average knowledge and skill values of SDN Sayung 3 and 4. Based on the research results obtained, it is known that the use of hots-based scientific learning models is proven to be effective in improving the comprehension concept and science students skill. In addition to testing the effectiveness of the model, researchers also observed student activities to strengthen research results. Besides, data analysis of student and teacher responses showed the highest positive results.

1. Introduction

Education continues to experience changes and improvements, one of which is curriculum changes that have occurred several times. This curriculum change is not about changing ministers and changing curriculum. But to improve education. Another academic justification is for curriculum changes as an effort to face even tougher challenges ahead, both for environmental problems, advances in information technology, economic globalization, and the rise of creative and cultural industries. All of that is intended to achieve the goals of national education as mandated in Law no. 20 of 2013 concerning the national education system, namely "the development of the potential of students to become human beings who believe and have devotion to God Almighty, have a noble character, are healthy, knowledgeable, competent, creative, independent,

Science learning is in line with the current curriculum development, namely the 2013 curriculum, which emphasizes scientific learning and involves all aspects of students' abilities in dealing with problems and involves all five senses in information discovery to make students active, creative, and thinking critically in solving problems in around. Therefore, the implementation of the 2013 curriculum requires a change in the learning paradigm, in which students are trained to learn to observe, ask questions, collect data, analyze (associate) data, and communicate learning outcomes which are called the scientific approach.
Teachers as the spearhead of education are required to be able to design effective learning and can realize educational goals in increasing understanding of concepts, skills as well as a student activity and creativity.[1][2][3]. Likewise, learning science is also expected to develop scientific understanding and skills. Science skills are intellectual skills needed in carrying out scientific investigations that students acquire as the results of learning science. Benchmark for success in managing science learning can be seen from learning that involves more students to act more actively and manages the findings obtained from aspects of science process skills, students' high-level thinking abilities. Higher- order thinking skills (HOTS) are a skill that should be present in every teaching. Teaching science particularly requires teachers to be skillful in planning learning activities that can inculcate thinking skills among students[4][5][6].

However, in reality, there are still many educational problems caused by the inaccurate management of learning carried out by the teacher and the low mastery of students' understanding, especially in science lessons. As the findings of observations and interviews conducted at SD 3 Saying, the curriculum used as a reference has used the 2013 curriculum, but in implementing the learning process it still uses a monotonous method so that understanding of the concept of science material is poorly understood and there is a lack of science skills in students in semester 2 2018/2019 school year. Research also shows that most students cannot transfer the knowledge they have learned in class using HOTS. This problem also occurs in the findings[7][8]

The HOTS-based scientific learning model is considered appropriate to emphasize learning that involves all aspects of the five senses in information discovery to make students active, creative, and thinking critically in solving problems around them, so they can master concepts and develop science skills. This is because HOTS-based scientific learning is a learning process designed in such a way so that students actively construct concepts, laws, or principles through the stages of observing (to identify or find problems), formulate problems, propose or formulate hypotheses, collect data with various techniques, analyze data, draw conclusions and communicate concepts, laws or principles found,[9][10][11][12][13]

Based on this background. Researchers are interested in analyzing the effectiveness of the Higher Order Thinking Skill (HOTS) based scientific learning model in improving mastery of science concepts and skills.

2. Methods
The method was quasi-experiment with Pretest-Posttest Control Group Design. The reason for choosing the experimental method is because an experiment in the field of education is intended to assess the effect of an action on behavior or to test the effect of the action. The action in the experiment is called treatment, which means the provision of the conditions for which the effect will be assessed.

The type of data obtained in this study is quantitative data. Quantitative data in the form of average scores, student questionnaires, and evaluation test results. These numbers are then qualified so that it can be concluded the level of effectiveness of the model. Data collection techniques in this study were used observation, student questionnaires, and student evaluation tests. The data collection instruments used was validation sheets, student questionnaires, and student evaluation tests.

The data analysis in the study using the homogeneity, normality, and T-test to test the effectiveness of the model.

3. Results and Discussion
3.1 Results
Homogeneity Test
Researchers calculated the homogeneity test using SSS version 23 with the following results,
Table 1. Test of Homogeneity of Variances

Value of Knowledge

| Levene Statistics | df1 | df2 | Sig. |
|-------------------|-----|-----|------|
| 4.15              | 1   | 44  | 0.523|

Table 2. Skill Value

| Levene Statistics | df1 | df2 | Sig. |
|-------------------|-----|-----|------|
| 3.028             | 1   | 44  | 0.089|

Based on the output table "Test of Homogeneity of Variances "Above, it is known that the significance value (sig) of the variable knowledge value and skill value can be concluded that the skill value of class A and class B is the same or homogeneous.

Normality Results

The normality test using SPSS is the Kolmogorov-Smirnov test with the criteria used to conclude that the data is said to be normal if the significant value is greater than 0.05 (P> 0.05). Conversely, if the significant value is less than 0.05 at (P <0.05), then the data is said to be abnormal.

Table 3. Normality results for the experimental class

| One-Sample Kolmogorov-Smirnov Test | Unstandardized Residual |
|------------------------------------|-------------------------|
| N                                  | 23                      |
| Normal                             | Mean, 0000000           |
| Parametersa, b                     | Std. Deviation, 674237249|
| Most Extreme Differences Absolute  | 215                     |
| Differences Positive Negative      | 215, 133                |
| Statistical Test                   | 215                     |
| Asymp. Sig. (2-tailed)             | 0.07c                   |
| a. Test distribution is Normal.    |                         |
| b. Calculated from data.           |                         |
| c. Lilliefors Significance Correction |                        |

Based on the output table "One-Sample Kolmogorov-Smirnov Test" above known value Sig. (2-tailed) of 0.007. Because the sig value is 0.07> 0.05, it can be concluded that the data we test are normally distributed.

Student learning outcomes in limited trials were known through the pre-test and post-test results. The results showed an increase, namely the percentage of achievement in learning outcomes, the knowledge and skill scores of students increased from an average of 68 to 82, and 68 to 77. Thus, there was an increase in the average learning outcomes of 0.65 and 0.39 so that it can be concluded that the scientific learning model HOTS-based is effective in improving mastery of science concepts and skills in limited trials in Table.
Table 4. Recapitulation of the value of student knowledge in limited trials

| Average Pre-test score | Average Posttest score | Score Maximum | Average n-gain |
|------------------------|------------------------|---------------|---------------|
| 62                     | 82                     | 100           | 0.65          |

Table 5. Recapitulation of students' skill scores in limited trials

| Average Pre-test score | Average Posttest score | Score Maximum | Average n-gain |
|------------------------|------------------------|---------------|---------------|
| 68                     | 81                     | 100           | 0.39          |

The increase in the average value of knowledge and skill value by the n-gain value is 0.65 and 0.39. The increase is in the medium category. These results indicate that the HOTS-based scientific learning model can be used to improve mastery of science concepts and skills.

Effectiveness Results (t-test)

To test the effectiveness of the development of this model, the One Group Pretest-Posttest Design was used. Effectiveness test (t-test). The t-test was used to test the significance of the difference between the two means from the two data distributions. The test of using the model aims to determine the achievement of the objectives of the HOTS-based scientific learning model.

Table 6. The results of the t-test pre-test the knowledge value of the control and experimental groups

| Value of knowledge | Equal Variances Assumed | T | Df | Sig. (2-tailed) |
|--------------------|-------------------------|---|----|----------------|
| 1.235              | 44                      | 0.224 |

| Skill value       | Equal Variances Assumed | T     | Df     | Sig. (2-tailed) |
|-------------------|-------------------------|-------|--------|----------------|
| 0.669             | 44                      | 0.507 |

Based on the output table "Independent Samples Test" above, it is known that the sig. (2-tailed) knowledge value is 0.224 and the sig (2-tailed) skill value is 0.507. Because the sig value is 0.224 and 0.507> 0.05, according to the basis of decision making in the independent sample t-test, it can be concluded that Ho is accepted and Ha is rejected, which means that there is a difference between the average knowledge and skill values of SD N Sayung 3 and SD. N Sayung 4.

In addition to testing the effectiveness of the model, researchers also observed student activities to strengthen research results. Data on the results of student learning activities in heat transfer learning. Observations were made in 2 learning activities. The observed aspects include observing, asking questions, gathering information, associating / reasoning, communicating, and evaluating.

Table 7. Recapitulation of Student Activities

| Score | Percentage | Category |
|-------|------------|----------|
| Meeting I | 50 | 67% | Enough |
| Meeting II | 64 | 85% | Well |
| Average | 57 | 76% | Well |
The percentage of student activity at the first meeting was 67% in the sufficient category and increased to 85% in the good category in the second meeting. The average percentage of effectiveness for meetings I and II is 76% which is in the good category.

Based on teacher respondents, the positive response given by the teacher is at the percentage level of 90% with the very good category. So that based on the results of these calculations it can be concluded that the development of HOTS-based scientific learning models is needed by teachers.

Table 8. The recapitulation of teacher responses to the HOTS-based scientific learning model.

| No. | Question                                                                 | Number of Teachers who Answered |
|-----|---------------------------------------------------------------------------|---------------------------------|
| 1.  | HOTS-based Scientific Learning Model is more useful for learning science  | Yes: 2                          |
| 2.  | The HOTS-based Scientific Learning Model made me more skilled             | No: 0                           |
| 3.  | HOTS-based Scientific Learning Model encourages me to find new ideas      |                                 |
| 4.  | The HOTS-based Scientific Learning Model made me understand more about science material |                       |
| 5.  | HOTS-based Scientific learning model helps me in delivering material      |                                 |
| 6.  | My HOTS-based Scientific Learning Model feels more motivated              |                                 |
| 7.  | HOTS-based Scientific Learning Model can explore me                       |                                 |
| 8.  | HOTS-based scientific learning model according to the 2013 curriculum     |                                 |
| 9.  | The appearance of the HOTS-based scientific model book is very attractive  |                                 |
| 10. | HOTS-based scientific learning model helps me in delivering experiments   |                                 |
|     | **Number of positive responses**                                         | 18                              |
|     | **Percentage of positive responses**                                     | 90%                             |
|     | **Positive response category**                                           | Very high                       |

Based on the table above, it is known that the teacher gave a positive response to the implementation HOTS-based scientific learning model with a very high percentage of student responses, namely 90%.

Table 9. The recapitulation of students' responses to the HOTS-based scientific learning model.

| No. | Question                                                                 | Number of teachers who answered |
|-----|---------------------------------------------------------------------------|---------------------------------|
| 1.  | Was today's lesson interesting?                                          | Yes: 53                         |
| 2.  | Are you happy with the learning that is being done?                     | Not: 3                          |
| 3.  | Can you come up with ideas during the lesson?                           |                                 |
| 4.  | Can you solve problems in science learning                              |                                 |
| 5.  | Do you understand science material when using scientific models?        |                                 |
| 6.  | Is the HOTS-based scientific learning model useful for                  |                                 |
Based on the table above, it is known that students give a positive response to the implementation of the HOTS-based scientific learning model with a very high percentage of student responses, namely 88%.

3.2 Discussion

Based on the research results obtained, it is known that the use of HOTS-based scientific learning models is proven to be effective to increase the comprehension concept and science students' skill in 5th-grade elementary school science skills. This can be seen from the t-test carried out using the SPSS 23 program to test differences in learning outcomes in the control and experimental groups before and after the trial. The criteria for the effectiveness of the media are if the t-test results for the pretest score have a Sig. (2-tailed) > α = 0.05; and the criteria for the posttest score are Sig. (2-tailed) < α = 0.05. T-test results in the value of sig. knowledge (2-tailed) are 0.224 and the skill value of sig. (2-tailed) is 0.507. Because the sig value is 0.224 and 0.507 > 0.05. This means that there is a significant difference in pretest learning outcomes in the control and experimental classes. The results of this study are in line with the following research which also reveals that the scientific model is considered effective in increasing student understanding[10][14][15][16][17].

The results also showed that the average score of the acquisition of critical thinking skills in the experimental class was higher in the control class, seen in the increase in the results of students' understanding and science skills. The results of this study were confirmed by research[18][19] who also found similar results.

Also, students responded positively to learning activities using the HOTS-based scientific learning model. Students enthusiastically participate in learning with the HOTS-based scientific learning model. However, there are still some students who are not ready for the learning process. In the control class, the teacher still uses monotonous learning, while students only listen and occasionally pay attention to the teacher’s explanation. The ability of students to think is less skilled because the teacher does not ask questions. Based on the research data it can be concluded that the learning outcomes in the experimental class are better than the control class, wherein the experimental class students are given treatment with a HOTS-based scientific learning model guide. This is because the HOTS-based scientific learning model emphasizes learning that involves all aspects of the five senses in information discovery to make students active, creative and thinking critically in solving problems around them, so they can master concepts and develop science skills. Because of the importance of implementing HOTS-based learning teachers and educators need to be aware of the importance and rationale of HOTS and become familiar with the various dimensions of HOTS before they can effectively develop these skills in their students.[20].

The results of the research on the implementation of science learning using a HOTS-based scientific approach showed an increase in student activity during learning.
The percentage of student activity at the first meeting was 67% in the sufficient category and increased to 85% in the good category in the second meeting. The average percentage of effectiveness for meetings I and II is 76% which is in the good category. This is supported by the positive response of students as high as 88%. This states that the HOTS-based Scientific Model is considered attractive to be able to involve students to actively participate in learning through practical activities with trained science process skills so that students are more enthusiastic in every stage and step in the learning that they follow. This finding is supported by research[21][22]. Besides, through the application of this model, students can find ideas during learning; students can solve problems in science learning; also provide opportunities for students to explore themselves.

The positive response of students is also in line with the positive response from the teacher, which is 90%. According to the teacher's opinion, the HOTS-based scientific learning model is in accordance with the 2013 curriculum, the HOTS-based Scientific Learning Model is more useful for learning science; the HOTS-based Scientific Learning Model encourages teachers to find new ideas in managing science learning, and helps teachers to instill understanding and improve student science skills. This result is reinforced by research that found the existence of The Effect of Scientific Process Skills Education on Students' Scientific Creativity, Science Attitudes and Academic Achievements,[23]. This research is further strengthened by[24] which states that Higher order thinking skill (HOTS) is one of the students' abilities that should be developed through teaching and learning. Teachers' knowledge about HOTS and its teaching and learning tactics is key to successful education.

4. Conclusion
Based on the analysis of the research results, it can be concluded that the use of the HOTS-based scientific learning model is proven to be effective in to be effective to increase the comprehension concept and science students skill in 5th grade primary school. Based on the T-test conducted, it was found that there were significant differences in pretest learning outcomes in the control and experimental classes. Besides, teachers and students gave positive responses about the meaning of learning by using this model in increasing mastery of science concepts and skills in science. Therefore, the results of this study can be used as a reference in implementing learning in schools.

Suggestions for teachers so that the results of this study can be used as a reference in implementing learning in schools.

References

[1] F. Alawiyah, "The Role of Teachers in the 2013 Curriculum," *Aspirations*, 2013.
[2] Ministry of Education and Culture, "Teacher Training Materials for 2013 Curriculum Implementation," *Development Agency. Mns Resources. Educator. and Kebud. and Educator Quality Assurance. Ministry. Educator. and Kebud.*, 2014.
[3] Nurdyansyah and EF Fahyuni, *Learning Model Innovation According to the 2013 Curriculum*. 2016.
[4] T. Sulaiman, V. Muniyan, D. Madhvan, SD Ehsan, W. Persekutuan, and K. Lumpur, "Implementation of Higher Order Thinking Skills in Teaching Of Science: A Case Study in Malaysia," *Int. Res. J. Educ. Sci.*, 2017.
[5] GS Pratama and H. Retnawati, "Urgency of Higher Order Thinking Skills (HOTS) Content Analysis in Mathematics Textbook," 2018, doi: 10.1088 / 1742-6596 / 1097/1/012147.
[6] C. Jerome, JAC Lee, and SH Ting, "What students really need: Instructional strategies that enhance higher order thinking skills (HOTS) among unimas undergraduates," *Int. J. Bus. Soc.*, 2017.
[7] SC Seman, WMW Yusoff, and R. Embong, "Teachers Challenges in Teaching and Learning for Higher Order Thinking Skills (HOTS) in Primary School," *Int. J. Asian Soc. Sci.*, 2017, doi: 10.18488/journal.1.2017.77.534.545.

[8] A. Surya, Sularmi, S. Istiyati, and RF Prakoso, "Characteristics of Elementary School Students," *Find. Hots-Based Math. Learn. Elem. Sch. Students*, 2018.

[9] E. Rofiah, NS Aminah, and W. Sunarno, "DEVELOPMENT OF HIGH ORDER THINKING SKILL (HOTS) BASED SCIENCE LEARNING MODULE TO IMPROVE THE CRITICAL THINKING ABILITY OF SMP / MTS STUDENTS," *INQUIRY J. Educator. IPA*, 2018, doi: 10.20961/inkuir.v7i2.22992.

[10] J. MARJAN, M. Arnyana, and M. Setiawan, "The Influence of Learning Scientific Approach on Biology Learning Outcomes and Science Process Skills of MA Students. Mu Allimat NW Pancor Selong, East Lombok Regency, West Nusa Tenggara," *J. Educator. and Indonesian Science Learning.*, 2014.

[11] DN, SP, Ernawati S, Khumaedi, Ani Rusilawati, "DIMENSION OF WANTING TO KNOW STUDENTS THROUGH A SAINTIFIC APPROACH TO THE ASSIST OF WATER CLEANING TOOLS," *Phenom. J. Educator. MIPA*, 2016, doi: 10.21580/phen.2016.6.2.1077.

[12] SR Yuliati and I. Lestari, "HIGHER-ORDER THINKING SKILLS (HOTS) ANALYSIS OF STUDENTS IN SOLVING HOTS QUESTION IN HIGHER EDUCATION," *Perspect. Science Educator.*, 2018, doi: 10.21009/pip.322.10.

[13] RGT Kusumah, "Improving Critical Thinking Ability of Natural Science Tadris Students Through a Scientific Approach in Integrated Science Courses," *IIJS Edu Indones. J. Integr. Sci. Educ.*, 2019, doi: 10.29300/ijisedu.v1i1.1762.

[14] A. Yani, S. Sahriah, and H. Haerunnisa, "THE EFFECTIVENESS OF A SCIENTIFIC APPROACH WITH HIGHER ORDER THINKING BOOKLET MEDIA ON BIOLOGY LEARNING RESULTS OF HIGH SCHOOL STUDENTS IN WAJO DISTRICT," *Biol Biol. Sci. Educ.*, 2018, doi: 10.33477/bs.v7i1.387.

[15] "THE EFFECTIVENESS OF THE PROBLEM-BASED LEARNING MODEL WITH A SCIENTIFIC APPROACH TO PROBLEM SOLVING ABILITY AND LEARNING INDEPENDENCE OF CLASS VII STUDENTS," *Unnes J. Math. Educ.*, 2016, doi: 10.15294/ujme.v5i2.11405.

[16] NP Aulia, N. Fadiawati, and L. Tania, "The Effectiveness of the Scientific Approach in Improving Conceptual Understanding of Mixed Separation Materials," *J. Educator. and Learning Kim.*, 2017.

[17] PAT Prasasti, "THE EFFECTIVENESS OF SCIENTIFIC APPROACH WITH GUIDED EXPERIMENT ON THE LEARNING OF SCIENCE TO EMPOWER STUDENT SCIENCE PROCESS SKILLS BASIC SCHOOL," *Educator Profession. Dasar*, 2018, doi: 10.23917/ppd.v1i1.3623.

[18] AC Saputri, Sajidan, Y. Rinanto, Afandi, and NM Prasetyanti, "Improving students’ critical thinking skills in cell-metabolism learning using the Stimulating Higher Order Thinking Skills model," *Int. J. Instr.*, 2019, doi: 10.29333/iji.2019.12122a.

[19] IW Widana, "Higher Order Thinking Skills Assessment towards Critical Thinking on Mathematics Lesson," *Int. J. Soc. Sci. Humanit.*, 2018, doi: 10.29332/ijsh.v2n1.74.
[20] A. Ghanizadeh, AH Al-Hoorie, and S. Jahedizadeh, "Higher order thinking skills," in *Second Language Learning and Teaching*, 2020.

[21] DE Wahyuni and A. Arief, "Implementation of Scientific Approach Learning with Higher Order Thinking Skills in Class X Optical Equipment Material at SMA Nahdlatul Ulama ‘I Gresik," *J. Inov. Educator. Fis.*, 2015.

[22] AU Hidayati and H. Retnawati, "Effectiveness Problem Based Learning And Scientific Approach To Improve Higher Order Thinking Skills," *Proceeding 3rd Int. Conf. Res. Implement. Educ. Math. Educ.*, 2016.

[23] H. Aktamis and O. Ergin, "The Effect of Scientific Process Skills Education on Students' Scientific Creativity, Science Attitudes and Academic Achievements," *AsiaPacific Forum Sci. Learn. Teach.*, 2008.

[24] H. Retnawati, H. Djidu, Kartianom, E. Apino, and RD Anazifa, "Teachers' knowledge about higher-order thinking skills and its learning strategy," *Probl. Educ. 21st Century*, 2018.