Effect of concept attainment model on student’s science process skills

A Halim1,3,*, S Farada1, A Hamid1, Mustafa1, Nurulwati1, E Mahzum1 and I Irwandi 2,3

1 Department of Physic Education, Training Teacher and Education Faculty, Universitas Syiah Kuala, Banda Aceh, Indonesia 23111
2 Department of Physic, Faculty of Science and Mathematics, Universitas Syiah Kuala, Banda Aceh, Indonesia 23111
3 The STEM Centre of Integrated Laboratory, Universitas Syiah Kuala, Banda Aceh, Indonesia 23111

*E-mail : abdul.halim@unsyiah.ac.id

Abstract. The research objective was to determine the effect of the concept approach model on students’ science process skills. The type of research used is experimental research with pre-experimental methods and one group pre-test post-test design. The research sample was selected for grade I at Peukan Bada Senior High School. Data collection used non-test instruments in the form of observation sheets to see students' science process skills. The results of data analysis using the percentage formula showed an increase in science process skills from the first meeting to the third meeting. At the first meeting, the average percentage was 54.66%, which was categorized as sufficient, at the second meeting it was 76.66% which was categorized as good, while at the third meeting it was 84.47% which was categorized as very good. The indicators of science process skills with the highest improvement were observation, interpretation, prediction, and concept application. Meanwhile, the lowest indicators are classification, experimental design, and communication.

1. Introduction

Brouner [1] first introduced ideas or thoughts about the concept attainment-learning model in his famous book entitled "Austin. A study of thinking" in 1956. In that book, Brouner said that human thinking should concentrate on the meaning and achievement of something, rather than accepting behavioural stimuli and responses. Grouping the same attributes into one class with special characteristics will produce something that is then called the concept of [2]. Words, meanings and concepts are the main and important benchmarks in the implementation of learning to produce concept acquisition [3]. Besides, the activity of observation and verbal coding of an object will result in retention, acquisition of concepts and can be generalized [4,5].

The concept attainment model is a form of learning to help students of all ages strengthen their understanding of the concepts being studied and practice testing hypotheses. In addition, it is stated that learning with the concept attainment model sharpens basic thinking skills [6]. Today's research, the concept attainment model is widely used as a form of learning model that can increase some of the latent variables that exist in students. Among them are to improve learning outcomes in mathematics and chemistry [7,8], reasoning ability with mathematical concepts [9], science process skills in fluid
concepts [10,11], understanding of mathematical concepts [12], social science achievement [13], ability communication in mathematics [14] and metacognitive skills of students [15]. Several previous researchers compared to several other types of learning have proved the superiority of the concept attainment-learning model. Among them, the concept attainment-learning is more advantageous than the self-directed learning model in improving mathematical learning outcomes [6], with discovery learning in improving students' problem solving abilities [16], with the Drill Skills model for improving physics learning outcomes [17], and is superior to the traditional model in improving the ability to teach English [18].

Besides the independent variables, the attainment concept model, there are also dependent variables that need to be improved through this study, namely science process skills. According to Padilla [19], science process skills are students' ability to apply scientific methods in understanding, developing and discovering science. Science process skills are very important for every student as a provision to use scientific methods in developing science and are expected to acquire new knowledge or develop the knowledge they already have. Several previous research results indicate that science process skills can be improved by using various forms of models, approaches or methods. Among them is through inquiry-based science teaching [20], using I diagrams and process skills [21,22], using computer simulations [23], using PhET simulation media [24], with inquiry learning activities [25], and with using a concept attainment model [10,11].

Based on several advantages of the concept attainment-learning model as shown by previous researchers, this model is suitable for use in improving science process skills. In addition, the syntax of the concept attainment model has conformity or synchronization with indicators of science process skills [10, 11, 26, 27]. The findings in the field, the results of observations at the target school (SMA Negeri 1 Peukan Bada, Aceh Besar) found that many students who did not understand the concepts of physics and students were less skilled in the learning process. Based on these three arguments, it is very appropriate to choose a learning model of concept attainment to improve science process skills.

2. Research Methods

2.1. Research Design
The approach used in this research is a quantitative approach with a pre-experimental method and the design chosen is one group pre-test post-test.

2.2. Population and Sample
The research target population was all students of SMA Negeri 1 Peukan Bada, Aceh Besar. While the samples were 31 students of class X MIPA-1. Because there is only one local in class X MIPA, the sample selection is not carried out in other words, the population automatically becomes the sample.

2.3. Implementation of Concept Attainment Model
This research was conducted at SMA Negeri 1 Peukan Bada on April 11 to April 25 2019, and the samples were 31 students of class X MIPA-1. The physics topics chosen in this study were Impulse and Momentum for 3 activities. Implementation of learning in the form of practicum activities for the concept of momentum (meeting 1), impulse (meeting 2) and conservation of momentum (meeting 3). Observers fill the observation sheets (OSSPS) during the practical implementation activities.

2.4. Data Collection
There is only one bound variable in the research, namely science process skills. Thus, the data collected was only from the science process skills variable using an observation questionnaire using a 4-point Likert scale. The non-test instrument was developed by researchers by adopting aspects and indicators of science process skills from previous researchers [28, 29,30]. The grid that forms the basis for the development of non-test science process skills instruments, includes 10 aspects with 31 indicators shown in table 1. Based on the aspects and indicators in table 1, an observation questionnaire of 31 items was
developed accompanied by a 4-point Likert scale called Sheet Observation of Science Process Skills (OSSPS).

Table 1. Science Process Skills: Aspects and Indicators.

| Code | Aspects          | Indicators                                                                 |
|------|------------------|-----------------------------------------------------------------------------|
| A1   | Observation      | 1. Using as many senses as possible                                           |
|      |                  | 2. Using relevant facts                                                      |
| A2   | Classification   | 3. Record every observation                                                  |
|      |                  | 4. Look for differences / similarities                                        |
|      |                  | 5. Contracting the features                                                  |
|      |                  | 6. Comparing                                                                 |
|      |                  | 7. Search for basic grouping                                                 |
|      |                  | 8. Connect the results of observations                                       |
| A3   | Interpretation   | 9. Finding patterns in a series of observations                              |
|      |                  | 10. Conclude                                                                 |
| A4   | Prediction       | 11. Using patterns / observations                                            |
|      |                  | 12. Tells what might have happened in an unobserved state                    |
| A5   | Asking question  | 13. Asking what, how and why                                                 |
|      |                  | 14. Ask for an explanation                                                   |
| A6   | Hypothesizing    | 15. Knowing that there is more than one possible explanation for an event   |
|      |                  | 16. Realizing that an explanation needs to be verified by obtaining evidence |
| A7   | Planning an experiment | 17. Determine the tools and materials used                               |
|      |                  | 18. Determine the variable or determining factor                             |
|      |                  | 19. Determine what to measure, observed and recorded                         |
| A8   | Using tools and materials | 21. Wearing tools and materials                                |
|      |                  | 22. Know the reasons why use tools and materials                             |
|      |                  | 23. Know how to use tools and materials                                      |
| A9   | Apply the concept| 24. Apply concepts to new situations                                        |
|      |                  | 25. Use concepts in new experiences to explain what's going on              |
| A10  | Communicate      | 26. Provide empirical data from experiment results with tables/graphs/diagrams|
|      |                  | 27. Deliver a systematic report                                              |
|      |                  | 28. Describe the results of the experiment                                  |
|      |                  | 29. Read charts                                                              |
|      |                  | 30. Discuss the results of activities                                        |

Sources: adopted [28, 29, 30]

2.5. Data Analysis
This research data is in the form of quantitative data that is collected using a questionnaire or observation sheet that is filled out by observers during the learning process. A 4-point Likert scale determines the choice of answer items, thus the research data is in the form of numbers from 1-4. The data analysis technique follows the following steps, namely (i) adding up the indicators of the observed aspects of science process skills and (ii) analysing the data from the assessment results of students' science process skills observation sheets with the percentage equation [31].

Table 2. Science Process Skills Category.

| Percentage | Category  |
|------------|-----------|
| 81 – 100   | Very good |
| 61 – 80    | Good      |
| 41 – 60    | Enough    |
| 21 – 40    | Less      |
| < 20       | Very less |

Sources: [31]
The results of the data analysis were interpreted into the five value criteria in table 2. The highest percentage, around 81-100 percentages were included in the Very Good category, while the lowest percentage or less than 20 percent were included in the Very Poor category. The other calcifications are shown in Table 2.

3. Results and Discussion

The implementation of this research aims to be able to see the effect of the concept-learning model on students' science process skills. The collection of data on science process skills used the LOKPS instrument. Data from the analysis results are displayed in accordance with the measurement aspects, namely (1) observation, (2) classification, (3) interpretation, (4) predictions / predictions, (5) asking questions, (6) hypothesizing, (7) planning experiments, (8) using tools and materials, (9) applying the concept, and (10) communicating for 3 treatments.

Table 3. Data analysis results on 10 aspects of measuring science process skills.

| No. | Aspect                | treat.1 (%) | treat.2 (%) | treat.3 (%) | Rata-Rata | Category   |
|-----|-----------------------|-------------|-------------|-------------|-----------|------------|
| 1   | Observation           | 75,80       | 94,00       | 100,00      | 89,93     | Very good  |
| 2   | Classification        | 16,70       | 46,00       | 62,90       | 41,86     | Enough     |
| 3   | Interpretation        | 64,50       | 97,00       | 100,00      | 87,16     | Very good  |
| 4   | Prediction            | 85,50       | 100,00      | 100,00      | 95,16     | Very good  |
| 5   | Asking question       | 50,00       | 87,10       | 98,00       | 78,36     | Good       |
| 6   | Hypothesizing         | 50,00       | 85,00       | 90,30       | 75,10     | Good       |
| 7   | Planning Experiments  | 33,30       | 62,40       | 77,40       | 57,70     | Enough     |
| 8   | Using Tools and Materials | 47,31   | 45,20       | 50,50       | 47,67     | Enough     |
| 9   | Applying Concepts     | 85,48       | 97,00       | 100,00      | 94,16     | Very good  |
| 10  | Communicate           | 38,10       | 53,55       | 65,20       | 52,28     | Enough     |
|     | average               | 54.66       | 76.66       | 84.47       | 71.93     | Baik       |

Based on the data in table 3, there are three forms of relationship, namely the type of concept practiced, the type of aspect, and the level of scientific process skills achieved. There are three practical topics carried out with the concept attainment model, namely the concept of momentum (meeting 1), impulse (meeting 2) and conservation of momentum (meeting 3). At meeting 1 the concept that was practiced was the concept of momentum. The implementation of the momentum concept practicum using the concept attainment model, as a whole has an impact on the sufficient category (54.66) on students' science process skills. However, there are aspects of science process skills that have an impact on good categories, including observation, interpretation, prediction, and concept application. While the rest are all in the sufficient and insufficient category. There is one aspect that is in the very poor category, namely classification. It can be understood that the implementation of practicum with the concept attainment model is less effective on the classification aspect of science process skills.

At the meeting of 2 the concept that is practiced is the concept of impulses. The implementation of the impulse concept practicum using the concept attainment model, as a whole has an impact on the good category (76.66) on students' science process skills. However, there are several aspects of science process skills that have an impact on the very good category, including observation, interpretation, prediction, asking questions, formulating hypotheses, and application of concepts. While the rest are all in the good and sufficient category. When compared with the results of the momentum topic practicum at meeting 1, the results at meeting 2 had a better impact on aspects of science process skills.

At the meeting of 3 the concept that is practiced is the law of conservation of momentum. The implementation of momentum conservation practicum using the concept attainment model, as a whole has an impact on the very good category (84.47) on students' science process skills. However, there are aspects of science process skills that have an impact on good categories, including classification and communication and have an impact on sufficient categories (using tools and materials).

Overall, it can be said that the implementation of practicum for the topic of momentum, impulse and conservation of momentum by using the concept attainment model has an impact on both categories of
science process skills. However, there are 4 aspects of science process skills that have sufficient or less impact on the implementation of practicum with this model, namely aspects of classification, planning experiments, using tools and materials, and communicating. The relationship between practical topics, SPS scores and SPS aspects is shown in Figure 1.

![Aspect of SPS vs Practicum Topics](image)

**Figure 1.** The relationship between practicum topics, SPS scores and SPS aspects.

Based on the graphic profile in Figure 1, it can be understood that the SPS score depends on different aspects of the contribution according to the practicum topic being carried out. The largest contribution of the SPS aspect to the SPS score was for the Momentum Conservation Law practicum with a percentage contribution of around 13.33%, while the smallest contribution was the Momentum topic practicum around 0.6%. In other words, to improve science process skills through the application of the appropriate concept attainment learning model is the implementation of practicum on the topic of the Law of Conservation of Momentum.

The findings of this study are supported by several previous studies related to improving students' process skills, including using inquiry-based worksheets [20], through the process skills approach [22], through PhET-assisted student worksheets [24], with guided inquiry [25], through a cooperative learning model [28] and through a genetic learning model [29]. Science process skills are also part of higher order thinking skills [32], in other words an increase in science process skills also increases students' problem solving abilities [33], critical thinking skills [34], generic science skills [35], and metacognitive skills [36].

**4. Conclusion**

Based on the results of the research above, it can be concluded that there is an effect of the conceptualization model on improving students' science process skills. This is indicated by the percentage of science process skills at each meeting. The percentage acquisition of the average value of the observation sheet at each meeting, which continues to increase, namely the first meeting obtained an average of 54.66%, the second meeting was 76.66% and the third meeting was 84.47%. Based on the research that has been done, the researchers put forward suggestions for future improvements. Based on the research that has been done using the concept grab model can have an effect on the improvement of students' science process skills on momentum, impact and collision material, then this model can be applied by educators in the learning process. It is hoped that the next researcher can make this writing as a basis for further research related to the concept attainment learning model and high-order thinking skills.

**5. Acknowledgement**

To all those who helped carry out this research, we would like to thank you very much. This study is funded by the NAS and USAID under the USAID Prime Award Number AID-OAA-A-11-00012, and
that any opinions, findings, conclusion, or recommendations stated in the article are from the author only, and do not always reflect the view of USAID or NAS.

6. References

[1] Bruner J S, Goodnow J J and George A 1956 Austin. A study of thinking. (New York: John Wiley & Sons, Inc).
[2] Haygood R C and Bourne Jr L E 1965 Psychological Review, 72, 175.
[3] Carroll J 1964 Harvard Educational Review, 34, 178.
[4] Rosenthal T L, Alford G S and Rasp L M 1972 J. of Experimental Child Psychology, 13, 183.
[5] Zimmerman B J and Rosenthal T L 1972 Journal of Experimental Child Psychology, 14, 139.
[6] Joyce B, Weil M and Calhoun E 2009 Models of teaching: Model-model pengajaran.
   (Yogyakarta: pustaka pelajar).
[7] Sukardjo M and Salam M 2020 International Journal of Instruction, 13, 275.
[8] Haetami A, Maysara M and Mandasari E C 2020 Jurnal Pendidikan dan Pengajaran, 53, 23.
[9] Srinok W, Angganapattarakajorn V and Jenjit A 2019 J. of Hum. and Soc. Sci., 21, 1.
[10] Ifrianti S, Amaliyah E, Komikesari H and Jamilah S 2019 J. of Phy.: Conf. Series, 1155, 1.
[11] Rani S A, Wiyatmo Y and Kustanto H 2017 Jurnal Pendidikan IPA Indonesia, 6, 326.
[12] Syafitri P A and Aini A N 2020 Jurnal Matematika dan Pendidikan Matematika, 2, 237.
[13] Habib H 2019 Shanlax International Journal of Education, 7, 11.
[14] Angraini L M 2019 Infinity Journal, 8, 189.
[15] McNaughton W 2011 Pedagogy in a New Tonality, 2, 235.
[16] Yuliati Y, Maridi M and Masykuri M 2017 1st Annual International Conference on Mathematics, Science, and Education., Atlantis Press.
[17] Wenno I H, Wattimena P and Maspaitela L 2016 International Journal of Evaluation and Research in Education, 5, 211.
[18] Ahmed I, Gujar A A, Janjua S A and Bajwa N 2012 Language in India, 12, 43.
[19] Padilla M J 1990 Research Matters-to the science Teacher, 9004, 45.
[20] Afrida J, Adlim A and Halim A 2015 J. Pendidik. Sains Indones. 3, 93.
[21] Karamustafaoğlu S 2011 International Journal of Physics & Chemistry Education, 3, 26.
[22] Bakar A, Halim A and Mursal 2015 J. Pendidik. Sains Indones. 03, 1.
[23] Siahaan P, Suryani A, Kaniawati I, Suhendi E and Samsudin A 2017 J.of Phy.: Conf. Ser. 812, 1.
[24] Arifullah, Halim A, Syukri M and Nurfadilla E 2020 J. Phys. Conf. Ser. 1460, 1.
[25] Rahmani, Halim A and Jalil Z 2015 J. Pendidik. Sains Indones. 3, 158.
[26] Reid B 2011 The Science Teacher, 78, 51.
[27] Kinghorn A 1991Nurse Education Today, 11, 310.
[28] Soraya V, Khalduun I and Halim A 2016 J. Pendidik. Sains Indones. 4, 53.
[29] Sharfina, Halim A and Safirri R 2017 J. Pendidik. Sains Indones. 5, 102.
[30] Zulfiani 2009 Strategi Pembelajaran Sains. (Jakarta: Lembaga Penelitian UIN Jakarta).
[31] Yusrizal, Halim A, Daud M and Saminan 2020 J. Phys. Conf. Ser. 1460, 1.
[32] Halim A, Ngadimin, Soewarno, Sabaruddin and Susanna A 2018 J. Phys. Conf. Ser. 1116, 3
[33] Halim A, Yusrizal, Susanna and Tarmizi 2016 J. Pendidik. IPA Indonesia. 5, 1.
[34] Wati S, Halim A and Mustafa 2020 J. Phys. Conf. Ser. 1460, 1.
[35] Razali, Halim A, Haji A G and Nurfadilla E 2020 J. Phys. Conf. Ser. 1460, 1.
[36] Junina, I Halim A and Mahidin 2020 J. Phys. Conf. Ser. 1460, 1.