The development of character and scientific knowledge of students through inquiry-based learning neuroscience approach

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Abstract. Famous scientific characters and knowledge are well developed and developed in the context of education in schools. This study aims to optimize the use of inquiry models based on neuroscience approaches in learning physics to improve students' character and scientific knowledge. This research is a quasi-experimental study conducted in one of the senior high schools in the tenth grade located in Bima Regency. The instrument used consisted of two tests to see an increase in scientific knowledge and a non-test to observe an increase in student character. Method This study uses one group pretest-posttest design and descriptive analysis techniques. The results of the research through the N-Gain normalization test showed that students' scientific knowledge increased in the medium category and the students' character developed well according to the implications after the application of inquiry learning through the neuroscience approach to learning physics.

1. Introduction

Character development in the world of education is needed so that children are not mistaken in seeing what should be bad is considered good or vice versa. In the context of the education paradigm, the learning process in its aim of preparing human resources for future development is essential [1,2]. This makes learning activities in schools face a highly competitive situation in producing high-quality and superior students in the era of globalization [3,4]. Education today is not only required as a means to educate students to have scientific knowledge and necessary academic skills, but also school must be able to develop the character of students to become excellent and intelligent individuals [5]. This competency is needed to face technological advances and developments in the latest industrial era [6]. in this condition, students must be optimal in increasing their potential in the realm of scientific knowledge and good character.

Efforts to develop character and enhance scientific knowledge of students must begin to be the concern of education implementers who are then applied in a quality learning process [7]. Physics learning, as part of science education, emphasizes on three aspects, namely knowledge, processes, and attitudes [8,9,10]. This physics learning is essential in providing insight to students to practice the ability
to think as well as skilled in acting to solve problems in everyday life. In learning physics in high school, students must be able to develop scientific knowledge, understanding and several abilities required to enter the higher education level in advancing science and technology in the future. In the stages of physics learning activities, students are emphasized actively in the inquiry activities as an effort to train students in possessing process skills, and sound scientific learning attitudes so that they can be used by teachers to instil positive character values [11].

The conditions that occur in physics learning activities that have taken place are different than expected. Many students found it challenging to understand Physics material clearly and directed so that the concepts and mathematical equations are given are not well absorbed in higher-order thinking skills. This was also discussed in previous research which found that students were not interested in learning physics because of the many complex mathematical concepts and equations [10]. The teacher is accustomed to abstractly giving Physics material, so the teacher's ability to train students to think scientifically and skillfully in the independent learning process is very lacking. Most students only rely on the ability to memorize and remember the material so that students do not have the character and good scientific knowledge during the learning process.

Innovative learning strategies needed to develop character and improve scientific ability are student-centred learning. Inquiry learning is one of the learning models that maximally involves all students' skills systematically, critically, logically, analytically so that they can formulate their findings with confidence [12]. Inquiry learning is centre on students, where students are encouraged to be directly involved in conducting investigative activities namely, asking questions, formulating problems, conducting experiments, collecting and analyzing data, drawing conclusions, discussing and communicating [13]. The training and habituation of students to think skillfully and physically skilled in inquiry learning is a prerequisite to achieving higher learning goals, namely the attainment of scientific skills and knowledge as well as the character and attitude of students as well as mastery of concepts, principles, laws and theories [14,15].

In optimizing the inquiry learning process, students maximize brain work and good focus. The use of innovative approaches that make maximum use of brain function has not yet been applied. Neuroscience is one of the new methods in learning that can help direct students to maximize brain function in the thought process, where the thought process itself is related to the readiness of the brain to start learning, know [16], behaviour, and good character. Some research results state that inquiry learning can improve students' critical thinking skills in learning physics [10,13]. The difference in research conducted through the neuroscience approach is more on students' ability to analyze data and information in a structured way by utilizing the focus of the brain's work so that it helps the inquiry learning process to the maximum so that the statement becomes something new in this study.

From the conditions above, this research needs to be carried out to investigate the development of students' increasing character and scientific knowledge through the use of inquiry learning models that are integrated with the neuroscience approach to physics learning. This study aims to see how the achievements of improving the character and scientific knowledge of students after the implementation of the inquiry learning process based on neuroscience approach.

2. Methods
This quasi-experimental study was conducted using non-probability sampling techniques [17,18]. The research took place in the tenth grade at one of the High Schools in Bima Regency. A sample of 32 students was selected by purposive sampling. One class group was taken in this study by using one group pretest-posttest design to collect students' scientific knowledge data and non-test using descriptive analysis techniques to see the percentage of student character achievements in several aspects. During the research students are first given a pretest, namely pretest, then students receive treatment by being taught using an inquiry learning model based on the neuroscience approach which is carried out in stages: (1) giving problems related to the material to be studied by students, (2) students conducting demonstrations through scientific inquiry activities, (3) students make questions (4) students discuss hypotheses, (5) students gather information (6) students test hypotheses, (7) students make accurate
conclusions and present them. After the learning material ends during the four meetings, students are then given a final test that is a posttest to see the achievements in improving students’ character and scientific attitude from before giving treatment and after giving treatment.

Data on scientific knowledge of students was collected using a written test with a total of 10 items about items that contained indicators of scientific knowledge. Three signs of scientific expertise are: 1) identifying scientific issues, 2) explaining scientific phenomena, and 3) concluding [19]. The test instrument used was valid and reliable to use, where the validity value was 0.8, and the reliability was r = 0.6. Student character data were collected using questionnaires and observation sheets which contained aspects consisting of 1) honest, 2) responsible, 3) creative, 4) thorough, 5) discipline and 6) Religious [20]. Data analysis techniques consist of two types, namely using descriptive statistics and inferential statistics with the normality test (N-Gain) [21].

3. Result and Discussion

3.1. Relationship between neuroscience-based inquiry learning with scientific knowledge

The research began with an unstructured observation stage to see students and class conditions as a sample. After the observation phase, the study is continued by giving initial tests to see how students understand the material to be taught. This test is carried out before providing treatment by applying inquiry-based learning to the neuroscience approach. During the learning process takes place changes in attitude, and increased student motivation through active learning activities. After the material is finished being taught, then students are given a final test to see the achievement of increasing scientific knowledge by using the N-Gain normalization test from the results of the initial examination and the final analysis. Inquiry learning with the neuroscience approach takes place over four meetings so that the results for each student's scientific ability score at the pretest and posttest.

The results of the analysis of students' scientific attitudes obtained are shown in Table 1 below:

| Test     | Score | <g> | Category |
|----------|-------|-----|----------|
| Pretest  | 32    | 60  | 15       | 36.84    | 0.59 | Medium |
| Posttest | 32    | 95  | 40       | 72.75    |

Based on the data in the analysis results shown in table 1, there is a significant difference between the effects of students' scientific achievement in the pretest and posttest. From the results of N-Gain obtained a reasonably high increase in scientific knowledge of students. Looking at the data description of the Normalized N-Gain test results of 0.59, it is said that the inquiry-based neuroscience approach is useful to improve students' scientific knowledge. Based on the results of research conducted, obtained the highest value for the percentage of achievement of increasing scientific understanding of students lies in the medium category with the number of 18 students while the lowest rate is in the moderate category with the number of 3 students and the rest are in the high class. Regarding the standard of scientific knowledge achievement in the small group shows that there is only a slight increase in student acceptance of the understanding of the material presented during the learning process. Some factors that cause low student scientific knowledge are also related to the lack of absorption and student readiness for learning.

Several research findings from the beginning to the end of the learning process show that inquiry-based neuroscience approach has a vital role in increasing students' scientific knowledge. This is evidenced by several supporting reasons, namely: changing attitudes and student learning motivation in a positive direction. Students' attitudes and learning motivations change for the better because during the inquiry learning process with a neuroscience approach students are invited to solve and analyze contextual problems related to the material being studied, thus making students more active in finding concepts, analyzing, and evaluating information collected through observation activities [12,13,22]. This makes students' cognitive abilities quantitatively improved because they are involved in
experimental activities as part of direct experience [22,23]. With the help of a neuroscience approach to inquiry learning, students have a better motivation to learn physics because students are activated to clarify the maximum thought process based on observational data [24]. Students are also asked to explain the description of the material through observation and inquiry activities. Then further students must make a relationship analysis and develop new concepts through scientific learning activities. This inquires learning with a neuroscience approach have a positive impact on student character in conducting independent learning [9,21].

Another finding obtained during the use of inquiry-based neuroscience approach is a better understanding of students' concepts due to scientific observations. This activity makes students able to analyze problems from the material being studied by gathering facts and information that they see and experience in everyday life. It is through observing and analyzing that students' scientific abilities develop to think, interpret data and prove it scientifically [21,23]. It is not only the ability to believe that develops, but the positive character of students through this inquiry activity becomes better because students must communicate and collaborate with their group friends in finding concepts [20,24]. With the stages of the neuroscience approach in inquiry learning, students become motivated to further optimize the work of the brain in shaping new understanding related to the attitude of active learning that is independent and structured [24,25,26]. Maximizing brain work and focus makes students trained in solving problems from the investigation activities carried out [8]. This process is unique because students have never been in a learning activity before being asked to focus and be optimal in thinking by forcing the work of the brain in groups to design their investigation activities by the data and facts they have collected. The stages of inquiry activities in the inquiry learning process provide opportunities for students to develop their potential both physically and emotionally [8,27]. In the next stage in inquiry learning with this neuroscience approach, students must make hypotheses and then explain the answers of these hypotheses using their language. This makes students' scientific and educational abilities better because students must express their opinions in front of others clearly and confidently [19,25].

3.2. The relationship between inquiry-based learning approaches neuroscience with character

Achievements to improve student character, observations were carried out using questionnaires and observation sheets which contained several aspects of personality that were honest, responsible, creative, conscientious, disciplined and religious. Based on research that has been done, it is obtained the percentage of students' character achievement data as shown in Figure 1.

![Figure 1. Results of Student Character Analysis](image)

In Figure 1, it can be seen that the Thorough aspect obtains the highest achievement of the characters and then followed by the creative element with an average percentage above 80%. This achievement is in the top category, which shows that inquiry learning with a neuroscience approach can build characters from the meticulous and creative aspects of students for the better. This is because inquiry learning and the neuroscience approach provide a series of activities that involve all the abilities and functions of the
students 'brain work to find out and investigate concepts systematically and logically so that students' accuracy develops well in being able to formulate their findings with confidence. Inquiry learning emphasizes the process of thinking critically and analytically to look for and find the answers themselves to a problem or theory described so that students' creativity can develop which is then used to arrange new ideas and concepts in the inquiry process [27]. The creative aspects of students preparing in inquiry learning occur when students are given the task to create ideas and express these ideas on the data that has been collected. The accuracy of students increases when students must be asked to correct opinions and collections of thoughts conveyed by peer groups [28].

In figure 1, it appears that the aspects of honesty, responsibility, discipline and religion are at a percentage below 80% where the lowest position is in the religious issue with the achievement of 60.40%. This percentage shows that inquiry learning with a neuroscience approach has not been able to develop the godly character well. This is because the inquiry learning process that is integrated with the neuroscience approach still focuses on high-level scientific thinking processes to train cognitive abilities and science process skills that prioritize creative and meticulous aspects in processing correct information [8,12,13]. Based on questionnaire analysis data and open observation sheets, it was found that some students were still difficult to be able to improve the character of discipline and responsibility because assignments given in groups and high-level thinking processes in the inquiry had not created a learning environment that required honesty and individual control. The religious aspect is not yet a concern in inquiry learning with a neuroscience approach, so students focus more on cognitive and psychomotor processes to understand concepts and material in Physics alone [19,20].

4. Conclusion

The conclusion in this study is the use of inquiry-based neuroscience approach can improve scientific knowledge which is seen from the results of the N-Gain analysis, which is in the medium category. After inquiry-based neuroscience approach learning is applied, some aspects of student character develop well and are in the high grade, namely creative and conscientious points followed by honest, responsible and disciplined elements which are in the medium category. In addition to the implications of scientific knowledge and character, it also increases motivation and changes in students' learning attitudes to become independent and active during the Physics learning process. Inquiry learning integrated with the neuroscience approach is a new method in its application to science learning so that in future research investigations can be carried out to see the effectiveness of inquiry learning with this neuroscience approach to other variables such as critical thinking skills and science process skills in more learning spaces significant.

5. References

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