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Junior High School Science Teachers' Perceptions of Science Scientists, Science Subjects, NOS, and NOSI

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Abstract— *This research aims to explore junior high school science teachers' perceptions of scientists, science subjects, the nature of science (NOS), and the nature of scientific inquiry (NOSI). Using a quantitative descriptive approach, this research involved 61 junior high school science teachers from various regions in Indonesia. A research instrument was developed, which included needs analysis, instrument design, instrument development, and instrument evaluation. The research results show that junior high school science teachers have mixed perceptions of scientists, with the majority recognizing the important role of scientists in the advancement of science and technology. However, there is a diversity of views regarding the physical and demographic characteristics of scientists. Regarding science subjects, teachers tend to have a positive perception of science's ability to develop students' critical and creative thinking skills. Teachers' perceptions of NOS show that most teachers understand the tentative nature of scientific knowledge and the importance of empirical evidence in science. Meanwhile, perceptions of NOSI show that teachers understand that scientific inquiry starts from curiosity about the natural environment, although there are variations in their beliefs regarding the effectiveness of inquiry models in learning. These findings emphasize the importance of ongoing professional development for teachers to increase their understanding of NOS and NOSI, as well as improve the quality of science learning in secondary schools.*

Keywords— Teachers' Perceptions; Science Scientists; Nature of Science; Science Inquiry.
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Introduction

In an era of globalization marked by advances in technology and information, a deep understanding of science is becoming increasingly important, especially among the younger generation. Science teachers at the junior high school level have a crucial role in shaping students' perceptions of scientists, science subjects, as well as fundamental concepts in science such as the nature of science and the nature of scientific inquiry. These perceptions not only influence students' motivation and interest in learning science, but also shape their attitudes toward scientific research and the application of science in everyday life. This research aims to identify and analyze these perceptions, as well as their implications for science teaching and learning practices at the junior high school level.

Scientists are often described through mental characteristics such as perfectionist, diligent, intelligent, imaginative, and open-minded, as well as physical characteristics such as wearing a lab coat, hairstyle, or glasses. This image is often influenced by information sources such as biographies, films, textbooks, and personal experiences. In addition, scientists are not always identified as distant figures, but can also be found in the surrounding environment such as teachers, parents, or even themselves [1]. Science subjects include two main elements, namely understanding science and process skills. Natural science understanding includes mastery of facts, concepts, principles, laws, theories, and models used to explain natural phenomena, while process skills involve a series of steps such as observing, questioning, planning investigations, analyzing data, and communicating results. These two elements are taught in an integrated manner to build a holistic and applicable understanding in the context of everyday life [2].

The nature of science (NOS) involves the understanding that scientific knowledge is tentative and subject to change as new evidence is discovered. Science is also influenced by the imagination and creativity of scientists in formulating hypotheses and theories. In addition, science has both objective and subjective characteristics, where objectivity is achieved through mechanisms such as peer review, while subjectivity arises from the scientist's personal beliefs, values, and cultural context [3]. Another opinion states that NOS (Nature of Science) refers to an understanding of the nature, principles and processes underlying science. NOS teaches that science is not just a collection of facts, but rather a dynamic process involving theories, experiments, and interpretations that can change as new evidence is discovered. Some of the key tenets of NOS include that scientific knowledge is provisional and subject to change, that science is subjective but seeks to be objective, and that the scientific method is open and

collaborative, allowing for the shared advancement of knowledge. A good understanding of NOS is important for increasing scientific literacy among students, especially in the educational context in Indonesia [4]. The nature of scientific inquiry (NOSI) emphasizes that scientific inquiry begins with questions and does not always follow rigid steps. The investigative process is guided by the questions asked, and the results obtained may vary even if the same procedures are used. In addition, research conclusions must be consistent with the data collected, and scientific explanations are developed through a combination of data and pre-existing knowledge [5]. Another opinion states that Nature of Science Instruction (NOSI) is a teaching approach that aims to help students understand the basic nature of science (Nature of Science, NOS), including how science works, how scientific knowledge is developed, and how science is dynamic and open to change. NOSI focuses on learning that not only provides facts, but also gives students an understanding of the scientific process involving experimentation, observation, data analysis, and interpretations that can change according to new findings. The aim of NOSI is to develop students' critical thinking skills and introduce them to the way scientists work in the search for knowledge [6].

Junior high school science teachers' perceptions of scientists and science subjects have significant urgency in the context of science education. Teachers who have a positive view of the role of scientists tend to inspire students to appreciate and understand the importance of science in everyday life and see the relevance of science in the real world. Meanwhile, teachers who consider science subjects as a crucial component in education will be more committed to teaching the material in an interesting and interactive way. This is important because science is the basis for many scientific disciplines and has a direct impact on student's ability to think critically and analytically. By highlighting the importance of scientists and science subjects, teachers can create a learning environment that encourages curiosity and scientific exploration among students, which in turn increases their interest and participation in science. Therefore, a deep understanding of this perception is mandatory for every educator to achieve better educational goals and strengthen students' foundations to continue their studies in the field of science and technology at a higher level. The urgency of investigating junior high school science teachers' perceptions of NOS and NOSI is of course based on several reasons, namely: to increase students' scientific literacy and increase student involvement in science learning. Therefore, it is important to understand the perceptions of science teachers so that they can become a reference for teachers to improve the quality and motivation of students in education in Indonesia.

Method

This research applies a quantitative descriptive approach, which focuses on presenting a detailed description of the results of a simple analysis regarding the percentage of respondents completing the questionnaire, without requiring inferential calculations. This approach aims to produce a fundamental and holistic analysis [7]. Quantitative descriptive research is describing, researching, and explaining something studied as it is, and drawing conclusions from phenomena that can be observed using numbers [8]. In the context of this research, the instrument developed aims to measure junior high school science teachers' perceptions of science scientists, science subjects, Nature of Science (NOS), and Nature of Scientific Inquiry (NOSI). The instrument development process follows the model proposed by Borg & Gall, which includes several stages, including needs analysis, instrument design, instrument development, and instrument evaluation. Each stage is carried out systematically to ensure that the resulting instrument meets the established validity and reliability criteria.

The population in this study consisted of junior high school science teachers using a sampling technique, namely random sampling, to obtain a representative sample. The research subjects consisted of junior high school science teachers in various regions in Indonesia. It is hoped that respondent participation will range from 50 to 100 teachers. After distributing the instruments, 61 respondents participated. Data collection was carried out for 2 weeks through a questionnaire specifically designed to measure teacher perceptions of various aspects. Data was collected through an online survey using Google Forms, where respondents were asked to fill out a questionnaire voluntarily. The online survey was carried out by sending a link, and distributing questionnaires online, while the offline survey was given physically to teachers at each school. The data obtained was analyzed using a quantitative descriptive approach, which includes an in-depth analysis of the results of numerical calculations in a simple way.

Result and Discussion

In the context of science education, teacher perceptions have an important role in shaping students' learning experiences. Science teachers at the junior high school level not only act as transmitters of material but also as mentors who influence students' understanding of scientists, science subjects, as well as the nature of science and scientific inquiry. This research aims to explore teachers' perceptions regarding these aspects, which can provide insight into how they interpret and teach science concepts. By understanding teachers' perceptions, in the future, we can evaluate their impact on the pedagogical approaches used in the classroom, as well as their implications for students' interest and motivation in learning science. Therefore, in this section, the researcher will explain the relevant findings and discuss the implications of teachers' perceptions of science teaching and learning practices at the junior high school level.

The perception instrument consists of 81 statements for closed statements, of which 20 questions are related to perceptions of science scientists, 20 questions are related to science subjects, 20 questions are related to NOS and 21 questions are related to NOSI. Then the open statement consists of 23 questions. The trial of the instrument for teachers' perceptions of science scientists, science subjects, the nature of science, and the nature of science inquiry was carried out for 2 weeks by distributing questionnaires online to science teachers in various regions, and offline to science teachers at SMPN 6 Mataram.

The author developed an instrument for perceptions of science scientists with indicators that include: (1) characteristics of scientists, including mental images (such as perfectionist, diligent, smart, imaginative, open-minded, inartistic, humane, responsible, religious, and peace-loving), the scientist's religion (atheist, religious, or religious), as well as education and academic

abilities; (2) physical characteristics of scientists, such as gender, age, hairstyle, glasses, beard or mustache, lab coat, bald, neat, boring, and workplace (lab, home, office, nature, classroom); (3) sources of images of scientists, which can be obtained from biographies, the internet, textbooks, science journals, films, teachers, newspapers, animated films, parents, museums, or cartoons; (4) scientists around us, who can be no one, teachers, parents/family, friends, or ourselves; (5) favorite scientist, including the name of the scientist (such as Edison, Graham Bell, Archimedes) and impression of the scientist (achievements, life story, physique, work, findings, role, way of working, abilities); and (6) the desire to become a scientist, namely whether someone wants to become a scientist or not.

The perception instrument for science subjects with indicators that include: (1) understanding of science, including mastery of facts, concepts, principles, laws, theories, and models in material used to explain, predict phenomena, and apply them in new situations; and (2) process skills, which consist of observing, questioning and predicting, planning and conducting investigations, processing, analyzing data and information, evaluating and reflecting, and communicating results. This instrument is designed to measure students' understanding and skills in learning science in a holistic and integrated manner.

An instrument for perceptions of the nature of science (NOS) was developed by the author with indicators including: (1) scientific knowledge is tentative, which means it can change along with the discovery of new evidence; (2) the nature of the observation, which is influenced by the observer's theory and presumptions; (3) scientific method, which is not single and varies depending on the research context; (4) hypotheses, laws and theories, as tools for explaining and predicting phenomena; (5) imagination, which plays an important role in innovation and scientific discovery; (6) validation of scientific knowledge, which involves empirical evaluation and conventions of the scientific community; and (7) objectivity and subjectivity in science, which reflects the balance between empirical facts and the influence of personal and cultural values. This instrument is designed to measure teachers' understanding of the nature of science in an educational context.

The perception instrument on the nature of scientific inquiry (NOSI) was developed with indicators that include: (1) recognizing and developing questions that can be answered through scientific knowledge and investigation, especially using experiments; (2) developing current questions related to everyday phenomena and can be answered with natural science knowledge; (3) plan appropriate investigations to test predictions and hypotheses; (4) conduct simple qualitative and quantitative experiments and other investigations, then write lab reports; (5) collecting data from investigations, especially experiments, or researching them; (6) identify trends, structures, and relationships in collected data, explain them, and draw conclusions; and (7) using appropriate models to solve science questions. This instrument is designed to measure understanding and application of the scientific inquiry process in the context of science learning. Through the development of a comprehensive instrument, researchers succeeded in identifying various indicators that reflect teachers' views, which can further influence pedagogical practices in the classroom. Results from this study indicate variations in perceptions that may impact teaching approaches and student motivation. In the next analysis, we discuss the findings in detail, explaining each perception according to the indicators that have been discussed.

Junior High School Science Teachers' Perceptions of Science Scientists

According to Chambers, standard indicators of the image of a scientist, namely a lab coat (usually but not necessarily white), glasses, facial hair growth (including an abnormally long beard, mustache or sideburns), research symbols: scientific instruments and laboratory equipment in any form, symbols of science [9]: especially books and filing cabinets, technology: the "products" of science, as well as relevant information: formulas, taxonomic classifications, "eureka"! syndrome, etc. Therefore, seven types of indicators were obtained. Each image is analyzed and given a score from one to seven to indicate the degree to which a standard image exists. The statement in the journal is in line with the indicators developed by researchers. Based on this, an instrument was developed with statements that correspond to each indicator. Each image is analyzed and given a score from one to seven to indicate the degree to which a standard image exists. The statement in the journal is in line with the indicators developed by researchers. Based on this, an instrument was developed with statements that correspond to each indicator. There are several sample criteria for questionnaire instruments that have been filled in by respondents which are then used as samples in this research as follows.

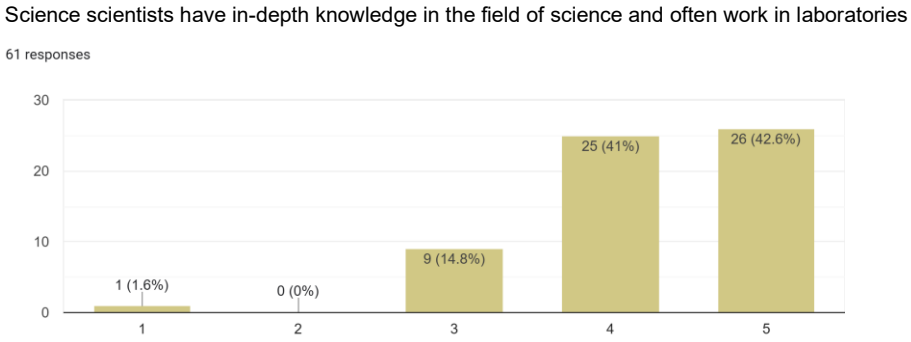

Fig 1. Domination Diagram of Perspective Indicators Filled in by Respondents Towards Natural Science Scientists

The results of the analysis of answers from junior high school science teachers to science scientists, 42.6% of respondents answered strongly agree and 41% agreed with the statement that scientists have in-depth knowledge and often work in laboratories (Figure 1). The statement that the average elderly scientist has varied answers, including 13.1% answered strongly agree, 32.8% answered agree, 29.5% answered quite agree, 21.3% answered disagree, and 3.3% answered strongly disagree. 37.7% agreed with the statement that most scientists are men, and 19.7% disagreed. Regarding the physical characteristics of scientists, such as having a mustache, beard, and messy hair, the majority of respondents, namely 29.5%, answered that they did not agree with this statement. The statement regarding the names of scientists in science books received 44.3% of respondents who answered agree and 36.1% answered strongly agree. The statement that respondents rarely see science scientists around their environment had varied answers, the 2 most frequent answers were disagree (24.6%) and agree (31.1%). The statement about scientists who make major contributions to science received positive answers, namely 1.6% quite agree, 14.8% agree, and 83.6% strongly agree.

Varied answers were again found in the statement about getting to know scientists from informal sources such as films, where most respondents answered quite agree (31.1%), and the least strongly disagreed (8.2%). Suitability of scientific background had the highest number of respondents agreeing (57.4%). The answer quite agree (41%) was the largest answer to the statement that leading science scientists rarely play a role in education or teaching in schools. Science scientists have an important role in the progress of science and technology (IPTEK), the most answers to this statement strongly agree (62.3%). 37.7% of respondents disagreed and 27.9% strongly disagreed with the statement that science scientists in general are less religious. For the statement that science scientists follow scientific methods to obtain acceptable results, all respondents gave positive answers, namely 13.1% quite agree, 50.8% agree and 36.1% strongly agree. To the statement about scientists' complex thinking abilities, the majority answered quite agree (36.1%). The role of scientists in science and technology received the most answers, namely strongly agree (50.8%). Scientists who are not active in communicating received the most answers as agreeing (36.1%), followed by disagreeing (34.4%).

Most respondents (54.1%) answered in the affirmative regarding scientists' experiments which can always be trusted, while 55.7% of respondents quite agreed that the research results of science scientists cannot always be trusted because they can change along with discoveries. 49.2% of respondents agreed that the knowledge developed by scientists is in line with current cultural or religious developments. The statement I am not interested in becoming a scientist received varying answers, namely 26.2% of respondents strongly disagreed, 42.6% disagreed, 23% quite agreed, and 8.2% disagreed, this indicates that of the 61 respondents, most were interested in becoming science scientists. From the analysis of these answers, it can be said that in the aspect of perceptions of science scientists, the average statement has varying answers.

From the analysis of respondents' answers to the image of a science scientist, it can be seen that their perceptions vary greatly, reflecting the complexity of their views on the figure of a scientist. Although many respondents agreed that scientists have in-depth knowledge and contribute significantly to the advancement of science and technology, there were doubts about the physical and demographic stereotypes of scientists, such as the assumption that scientists are generally male or older. These results show that although there is recognition of the vital role of scientists, there is still a gap in understanding the diversity and characteristics of scientists in society. In addition, the high interest in becoming scientists among respondents indicates the potential for future generations to be more actively involved in the world of science, which needs to be supported by inclusive education and an environment. In conclusion, this research highlights the importance of increasing the understanding and representation of scientists in education to encourage broader interest and participation in science.

Junior High School Science Teachers' Perceptions of Science Subjects

Respondents' perspectives on science subjects are an important aspect in understanding how individuals interpret and respond to science learning. Research that explores this perspective can provide deeper insight into the effectiveness of teaching methods and how students interact with scientific concepts. In this context, several factors can influence respondents' perspectives, including previous learning experiences, understanding of science, and the socio-cultural context of the subject teachers themselves. There are several sample criteria for questionnaire instruments that have been filled in by respondents which are then used as samples in this research as follows.

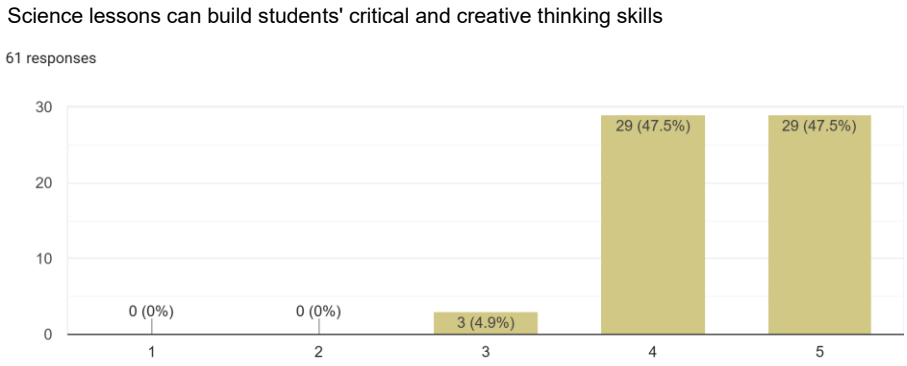

Fig 2. Domination Diagram of Respondents' Perspective Indicators on Science Subjects

Analysis of questionnaire answers on aspects of science subjects, including the statement that science lessons can develop students' critical and creative thinking skills (Figure 2), received a positive response, namely 47.5% strongly agreed, 47.5% agreed, and 4.9% quite agreed. There is no negative response in this statement. This indicates that junior high school science teachers have a positive perspective on science subjects. Apart from that, for another statement, namely regarding science subjects being important to study, where respondents answered strongly agree (85.2%) and agree (14.8%). Most respondents answered in agreement (50.8%) to the statement that science lessons were difficult. Positive responses were obtained (strongly agree 59%, agree 37.7% and quite agree 3.3%) to the statement about often linking science lessons with everyday life. The statement about science lessons being less interesting received the most answers, namely strongly disagree (45.9%) followed by disagree (34.4%). Positive answers were obtained, namely strongly agree (47.5%), agree (45.9%) and quite agree (6.6%) to the statement that respondents were motivated and confident in learning science. Various answers were obtained regarding the statement regarding the inadequate facilities and means of supporting science learning, 8.2% answered strongly agree, 36.1% agreed, 18% quite agreed, 29.5% disagreed and 8.2% strongly disagreed. Meanwhile, for the statement that respondents can observe students' abilities well, they received positive answers, namely 13.1% quite agree, 63.9% agree and 23% strongly agree. The statement regarding respondents' lack of ability to analyze students' knowledge received the highest number of answers, namely disagreeing (55.7%). Science lessons can build critical and creative thinking skills, getting the same percentage of agree and strongly agree answers, namely 47.5%, while moderately agree is only 4.9%. Most of the answers to perceptions of science subjects tend to be the same, with only a few answers varying, so it can be said that junior high school science teachers' perceptions of science subjects are relatively the same.

Junior High School Science Teachers' Perceptions of Nature of Science (NOS)

There are three important aspects of NOS. First, seeing the world as understandable and understanding that science cannot answer all questions. Second, understanding the nature of scientific investigation (understanding that investigations in science are based on reasoning and are experimental but involve suggested imagination and explanation). Third, understand the social and political aspects of science [10]. Respondents' perspectives on the concept of nature of science are very important to understand how individuals assess and appreciate the nature and process of science. Research exploring this aspect could provide a clearer picture of how students understand the characteristics of science, including the provisional nature of scientific knowledge and the role of theory in the development of science. Various factors, such as previous learning experiences, the influence of the social environment, and understanding of the scientific method, can influence respondents' views on the nature of science. In this research, the questionnaire instrument used was designed to collect information from respondents regarding their views on the nature of science. There are several sample criteria for questionnaire instruments that have been filled in by respondents which are then used as samples in this research as follows.

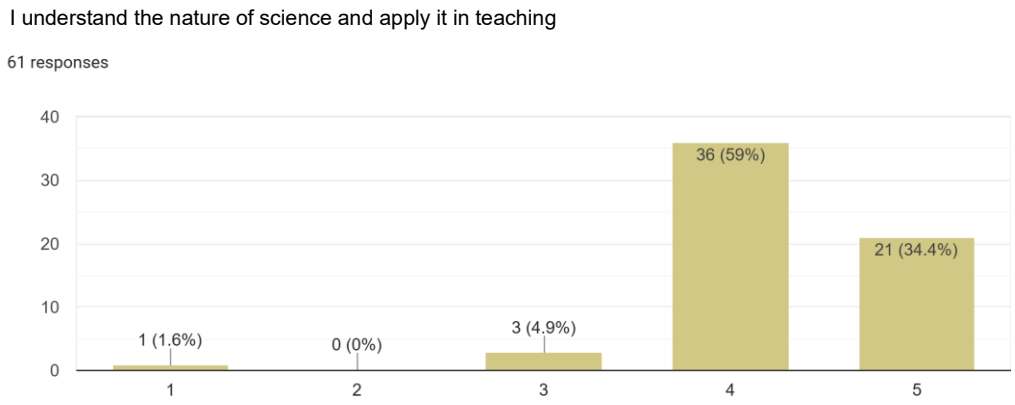

Fig 3. Domination Diagram of Perspective Indicators Filled in by Respondents on Nature of Science (NOS)

Junior high school science teachers' perceptions of the nature of science can be concluded through the following analysis of answers. Most teachers feel that they understand the nature of science and apply it in teaching (Figure 3), which can be seen from the percentage of answers agreeing at 59% and strongly agreeing at 34.4%. This shows a positive response, that the perspective of the majority of junior high school science teachers states that they understand NOS well and apply it in teaching at school. This perspective is reinforced by the answers to other statements. The statement that science is tentative and research findings can be updated received the highest percentage of agree answers, 65.6%, and strongly agree, 26.2%. Teachers tended to answer strongly agree (44.3%) and agree (49.2%) to the statement regarding the belief that science is based on testable evidence. The percentage of answers related to NOS in science learning is more varied than statements about NOS alone. However, when connecting the statement with the scientific method, respondents' answers were relatively the same, namely they tended to answer positively, or tended to be negative depending on the statement.

Junior High School Science Teachers' Perceptions of Nature of Scientific Inquiry (NOSI)

Respondents' views on the nature of scientific inquiry are key in understanding how individuals go through the process of scientific inquiry and making decisions based on data and evidence. Research that focuses on this aspect can reveal how well students understand the scientific method, including questions, hypotheses, experiments, and data analysis. Various factors, such as teacher training, access to resources, and practical experience in research, contributed to the way respondents viewed and experienced scientific inquiry. In this context, the questionnaire instrument applied in this research functions to explore respondents' understanding of the process and importance of inquiry in science. General aspects of scientific inquiry state that; a) Scientific investigation begins with a question, b) Scientific investigation includes various methods, c) The process of scientific investigation is managed by research questions, d) Scientists who carry out the same procedure may find different conclusions, e) Research procedures can influence research results, f) Research results must be consistent with the data obtained, g) The difference between data and evidence, and (h) The explanation of research results is a combination of the data obtained and the literature [11]. There are several sample criteria for questionnaire instruments that have been filled in by respondents which are then used as samples in this research as follows.

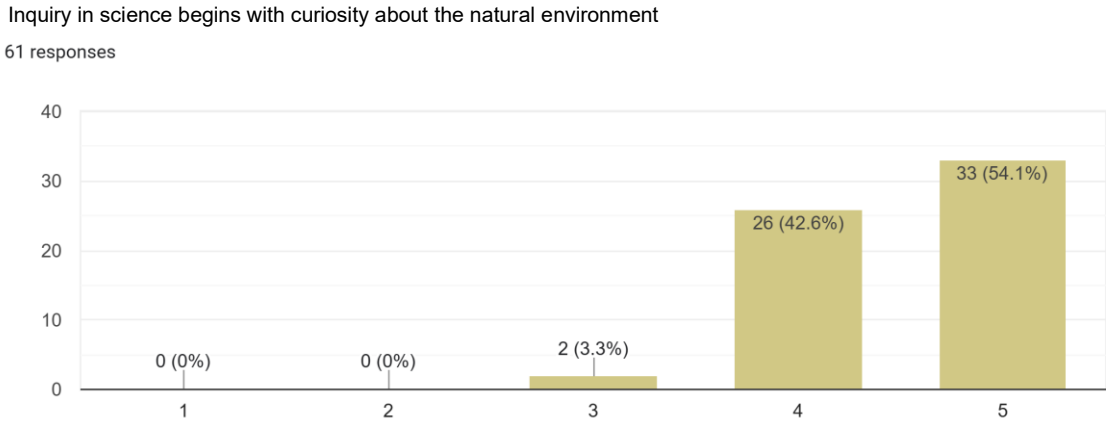

Fig 4. Domination Diagram of Perspective Indicators Filled in by Respondents on Nature of Scientific Inquiry (NOSI)

Analysis of perceptions of the nature of scientific inquiry tends to have relatively the same answers, although there are some varying answers. Statements that had answers tended to be the same, including those regarding inquiry in science starting from curiosity about the natural environment (Figure 4), all of which had positive answers, namely quite agree 3.3%, agree 42.6%, and strongly agree 54.1%. This states that the majority of junior high school science teachers understand the nature of inquiry science. Apart from that, the statement about assessing students' success after participating in inquiry learning had a percentage of answers of disagree 1.6%, quite agree 16.4%, agree 65.6% and strongly agree 16.4%. One example of a statement that has varied answers is about respondents not being confident about the effectiveness of the inquiry model in science learning, where the answers were 14.8% strongly disagree, 47.5% disagree, 24.6% quite agree, 9.8% agree and 3.3% strongly agree. Therefore, junior high school science teachers' perceptions of the nature of inquiry science vary.

The answers to the open questions in the questionnaire showed significant consistency with the results of the closed questions, strengthening the findings obtained. Respondents generally expressed similar views regarding the characteristics of scientists and the importance of science teaching, with many highlighting the need for a deeper understanding of the nature of science. Most teachers gave positive responses about the role of scientists in education and the advancement of science, which is in line with the results of the closed questionnaire which shows that they believe scientists have in-depth knowledge and contribute greatly to the development of science concepts. Thus, the analysis of these open-ended answers not only confirms but also enriches the understanding of teachers' perceptions of science and the role of scientists in educational contexts.

Based on the results of the analysis, it can be concluded that middle school science teachers' perceptions of scientists, science subjects, and the nature of science and scientific inquiry show the diversity that reflects the background and experiences of each individual. Although many respondents recognized the importance of science teaching and the role of scientists in the advancement of science, there was variation in beliefs and understanding of the nature of scientific inquiry. These findings emphasize the importance of ongoing professional development for teachers to strengthen their understanding and improve the quality of science teaching in schools.

Conclusion

Based on the research results, it can be concluded that middle school science teachers' perceptions of scientists, science subjects, the nature of science (NOS), and the nature of scientific inquiry (NOSI) reflect a diversity of views influenced by the background and experience of each teacher. The majority of teachers recognized the important role of scientists in the advancement of science and technology, although there was variation in their understanding of the physical and demographic

characteristics of scientists. Teachers also have positive perceptions of science subjects, especially in terms of developing students' critical and creative thinking skills. However, there is variation in teachers' understanding of NOS and NOSI, indicating the need for increased understanding of the tentative nature of scientific knowledge and the process of scientific inquiry. This research emphasizes the importance of ongoing professional development for teachers to strengthen their understanding of these concepts, thereby improving the quality of science learning in secondary schools. Thus, it is hoped that this research can become a basis for developing more effective teacher training policies and programs in the future.

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