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Nature of Science and Students' Religious Beliefs

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Abstract

This study aims at exploring primary school students' perceptions of NOS and their religious beliefs. Students' understanding of the nature of science and students' religious belief were measured using a four-scale questionnaire. Participants of the study were 109 grade five and six students who were willing to participate in an online survey. The findings show that students have a good understanding of NOS in the aspect of subjectivity, creativity, socio-cultural closeness, empirical aspect, observation and inference, scientific method, and scientific ethos. However, their scores on the tentativeness of science, scientific laws, and scientific theories are fairly low. With regard to their religious belief, they believe that the creation of nature is evidence of God's power that can be proven by science. They believe that conducting a scientific investigation is part of the worship of God.

Discipline: Science Education, Religion & Believe, Primary Education.

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1 Introduction

Scientific knowledge is often considered as contradicting to religious beliefs by students (Southerland & Scharmann, 2013), causing them to reject science (Bickmore et al., 2009), and creating a barrier to learning science (Reiss, 2010). Meanwhile, the development of scientific knowledge is very closely related to socio-cultural values such as social order, religion, etc. (Lederman, 2006). Science and religion are ways to understand and know the outside world through scientific explanations that are logical, empirical, tentative, limited, and do not use supernatural

powers (Shamim, 2015). Religion in science acts as the value of one's belief to show evidence of the greatness of God in the creation of nature (Anwar & Elfiah, 2019; Arsyad, 2016). Thus, the more religious the students are, the more attention they will pay to socio-cultural science and the more it encourages them to carry out scientific investigations more broadly (Aflalo, 2013). Therefore, religion and science are incomparable.

Scientific knowledge leads to an understanding of the characteristics of science, what science is and how scientific methods are carried out. These characteristics are closely related to the nature of science (NOS) which refers to the epistemology of science, methods, values, and beliefs in scientific developments (Lederman et al., 2002). NOS also describes the meaning of science, how it works, and the way scientists operate as social groups that direct them to react to scientific endeavors (McComas et al., 1998).

NGGS (Next Generation Science Standards) emphasizes that NOS should be understood by educated citizens to encourage them to understand the characteristics of scientific activities (Bybee, 2014). NOS must also be understood by students because it is related to the era of science content and the way it is presented to students, the understanding of science, the way science works, and other important issues. Furthermore, the teaching of NOS is an important basis for improving student literacy (Piliouras et al., 2018). Therefore, NOS has become the main goal of science education in many countries (Olson, 2018).

Based on the survey results of Trends in International Mathematics and Science Study (TIMSS), the science ability of Indonesian elementary school students is ranked 44th out of 49 countries that belong to the low category. This may be caused by the low understanding of students toward NOS. Understanding NOS is an important aspect of scientific literacy (Widodo et al., 2019). NOS consists of subjectivity, creativity, tentative aspects, scientific law and theory, socio-cultural closeness, empirical aspect, observation and inference, scientific method, and scientific ethos (Kampourakis, 2016). Science or scientific work is run not only on the logical basis of science (as its objective basis) but also based on a paradigm (as its socio-cultural basis) and a theological-metaphysical basis (as its religious basis) (Muslih, 2010). In religion, nature is a tribute to God in the form of admiration for the beauty, breadth, and interconnectedness of the cosmos that shows the wonders of the universe. This is the highest level of belief that not only reveals the mystery but also tells us how we should live.

However, only a few results of interaction studies between NOS and religion were found. The results of NOS and religious belief research have often been studied separately, especially in elementary schools. In general, the results of studies on the interaction between religious beliefs and scientific concepts illustrate the conflicts experienced by some students (Brickhouse et al., 2000). In a study with conflict approaches, controversies and conflicts were found between religion and the theory of evolution (Barnes et al., 2017). On the other hand, the natural theology approach is suggested in designing arguments to reconcile science and religion, but this association does not

work well for the concepts of chemistry, engineering, technology, and other sciences involved in the transformation of reality (Drees, 2005).

Based on the results of the study, the interaction of NOS and religion has not become an important concern in elementary schools. Therefore, it is important to conduct an in-depth study related to the interaction of NOS and religious beliefs in elementary schools. Therefore, this study aims at exploring primary school students' perceptions of NOS and their religious beliefs.

2 Literature Review

2.1 Nature of Science

The nature of science refers to the value or belief in science. The nature of science refers to the characteristics or characteristics of science (N. G. Lederman et al., 2014). In general, experts describe aspects of the nature of science consisting of; (1) Subjective, (2) Tentative, (3) Creativity, (4) Scientific law and theory, (5) Social and cultural, (6) Scientific method, (7) Empirical, (8) Scientific attitude. Scientific knowledge is influenced by the subjectivity of scientists such as personal values, beliefs, experiences, and the scientist's agenda (Adi & Widodo, 2018). The characteristic of the nature of science is that scientific knowledge and socio-culture have closeness. Scientific knowledge is influenced by the activities and socio-culture of the local community, and vice versa (Ağlarcı et al., 2016). Scientific knowledge is built on the scientific attitude of scientists in conducting scientific investigations. Scientific attitudes such as honesty, curiosity, caring, cooperation, and critical (Sardinah et al., 2012).

2.2 Religious Beliefs

Religion is obedience in the form of submission to God (Shihab, 2021). Religious beliefs become an integral part of the science learning process. As religion teaches us to explore and research this universe to see the greatness of God in the creation of nature (Anwar & Elfiah, 2019; Arsyad, 2016). The religious belief in science learning can refer to the belief that science is a way to know the greatness of the Almighty God. Religious beliefs in science learning can be believed that the universe was created as a sign or proof of the greatness of God in the creation of nature (Afifah et al., 2020). Religious belief in science learning also leads to the belief that the human senses, reason, and conscience are valuable instruments for observing the creations of God Almighty. Humans are given hearing, sight, and conscience (Darmana, 2016). They have the belief that scientific investigation is a process to show evidence and signs of God's greatness in the creation of nature (Sani, 2015; Tursinawati et al., 2022) and the belief that the positive attitude and role of humans towards the universe (Amin & Siregar, 2015).

3 Method

This study relied on a survey research method. The research subjects were 109 elementary school students in Indonesia, consisting of 58 boys and 51 girls in the fifth and sixth grades of elementary school. The age of the students ranged from ten to eleven years. A total of 26 elementary school students come from several regions in Indonesia.

Data was collected using an online survey using Google Forms. The data were obtained by students' NOS and religious belief questionnaires in obtaining knowledge. The NOS questionnaire consists of 28 statements in the form of a closed questionnaire with a Likert scale (strongly agree, agree, disagree, and strongly disagree with a scale of 4, 3, 2, and 1). The NOS aspects studied are subjective, creativity, tentative, socio-cultural, scientific law and theory, observation and inference, scientific method, and scientific attitude.

The close questionnaire on students' religious beliefs in obtaining knowledge consists of 30 statements in the form. The aspects of religious belief in science learning are 1) science is a way to know the greatness of God's creation, 2) the universe is a sign of the greatness of God's creation, 3) human senses, reason, and conscience are valuable instruments for observing the creation of God Almighty, 4) investigation is a process to show signs of the greatness of God Almighty, 5) the role and attitude of humans towards the universe is an act of worship to his Lord (Tursinawati & Widodo, 2019).

The questionnaire has been tested for validity and reliability. The validity and reliability tests used the SPSS (Statistical Product and Service Solutions) program with the Bivariate Pearson correlation test technique (Pearson Moment Product). The questionnaire data of NOS and students' religious beliefs in acquiring knowledge consisted of positive and negative statements. The quantitative data obtained were given criteria, namely Strongly agree (4), Agree (3), Disagree (2), and Strongly disagree (1) on positive statements, but the opposite applied to negative statement scores. Next, the researchers tabulated the scores and calculated them in percentage form using Microsoft Excel. The results of the analysis are presented with a percentage description criteria diagram. Furthermore, the data were described qualitatively and analyzed in-depth to be interpreted. Data on NOS perceptions and religious beliefs were analyzed based on the percentage of the four criteria. Then, the data were interpreted based on the highest and lowest occurrences of each statement on the NOS and students' religious beliefs. In the final stage, the data were concluded.

4 Result and Discussion

4.1 Nature of Science Perception of Elementary School Students

Elementary school students' perceptions of NOS showed that most of them had a positive percentage compared to those who did not agree. This means that most students believe that, in obtaining knowledge, they should understand the characteristics of NOS while others think otherwise. Based on the data obtained, the results of student responses from 28 statements related to NOS indicate that most students tend to strongly agree (32.87%) and agree (47.44%) with NOS. Some aspects of NOS have not been well understood by students with the percentage of disagreeing of 13.91% and strongly disagreeing of 5.77%.

Table 1: Percentage of elementary school students' perceptions of NOS

Aspek NOS	Student response			
	Strongly agree	Agree	Disagree	Strongly disagree
Subjektive	33.77	53.95	8.77	3.51
Creativity	31.14	47.81	13.60	7.46
Tentativeness	25.44	42.98	21.93	9.65
Sosial and culture	30.26	52.63	13.16	3.16
Scientific law and theory	19.30	42.11	28.51	10.09
Empirical evidence	45.39	49.34	4.61	0.66
Observation and inference	48.68	41.67	7.02	2.63
Scientific methods	29.39	53.07	13.16	4.39
Scientific ethos	32.46	43.42	14.47	9.65
Average	32.87	47.44	13.91	5.77

In general, students have a good understanding of NOS in terms of subjective, creativity, socio-cultural closeness, empirical, observation and inference, scientific method, scientific ethos, cooperation, and collaboration. However, they do not understand NOS well in the tentative aspect, scientific law, and scientific theory. Most of them obtained a high percentage on the statements "Strongly agree" and "Agree" on subjectivity, creativity, socio-cultural closeness, empirical aspect, observation and inference, scientific method, scientific ethos, cooperation, and collaboration. Meanwhile, some other students obtained the lowest percentage on the statements "Strongly agree" and the highest on "Disagree" and "Strongly disagree" on the tentative aspect, scientific law, and scientific theory.

Elementary school students agree with all aspects of NOS. Most students agree with the subjective aspect, creativity, tentative, socio-cultural closeness, scientific law, and theory, empirical aspect, observation and inference, scientific method, and scientific ethos. This shows that most students strongly agree that science is obtained from observations and research conclusions. Most students strongly agree that scientific knowledge is empirically based which involves investigation, observational evidence, and measurement. They agree that knowledge is influenced by personal subjectivity which includes values, beliefs, self-agendas, and experiences. For the scientific method, they agree that there is no universal scientific method/step. For the socio-cultural closeness, most of them believe that scientific knowledge is influenced by and can affect people's lives (social, economic, ethical, cultural, and technological aspects). From this percentage, it appears that students agree that scientific knowledge is created from imagination and creativity; science is tentative; science consists of scientific theories and laws; scientific knowledge requires observation and conclusions in research; scientific knowledge is built on the work ethic of scientists; scientific knowledge is developed through interaction and collaboration between scientists.

These results follow the findings of the previous study (Petersen et al., 2020) that there is a significant influence on learning on aspects of NOS such as subjective, social, and cultural aspects of science. The understanding of NOS in terms of subjective, empirical, and tentative aspects, in general, has also increased (Khishfe, 2013). Another finding shows that in the development of the

NOS perception, the most significant aspects are empirical aspects, theoretical requirements, creativity and imagination, and socio-cultural attachments in science (Ağlarcı et al., 2016).

The data show that students do not have a good understanding of scientific law and theory and tentative aspects. On the aspect of scientific law and theory, only a few students strongly agree. A small number of students believe that scientific law and theory have the same position in science. Students have doubts about the position between scientific law and theory. They tend to misunderstand scientific law and theory because they think that theory has a lower position than scientific law. They believe that theories need additional evidence to become scientific laws. Likewise, in the tentative aspect, only a few students strongly agree that scientific knowledge has limitations, and is durable, but can change with new and stronger evidence or ideas. Some students have misconceptions regarding the tentative aspect because they believe that scientific knowledge is true and does not change.

These findings also show that students do not yet have a good understanding of the tentative aspects, scientific laws, and theories. In accordance with previous studies, in general, students do not understand the scientific aspects of the difference between scientific laws and theories and tentative aspects (Mesci & Schwartz, 2017). Another study shows that students are naive regarding the scientific method; they believe there is only one method that scientists should follow in obtaining knowledge (Köksal & Şahin, 2014). Therefore, teachers should be able to emphasize scientific law and theory and tentative aspects in explaining NOS during learning.

4.2 Students' religious beliefs in acquiring scientific knowledge in science learning

The elementary school students' perceptions of religious beliefs in obtaining knowledge obtained a positive percentage compared to those who did not agree. From these findings, most students believe that, in obtaining scientific knowledge, they can recognize the greatness of God in the creation of nature through evidence of natural phenomena and the process of scientific investigation. Based on the results of student responses, the science of religious beliefs shows that most students strongly agree (54.10%) and agree (31.80%). The other indicated that they did not agree (9.70%) and strongly disagreed (4.40%).

Table 2: Percentage of students' religious beliefs in acquiring scientific knowledge

NOS. aspect	Student response			
	Strongly agree	Agree	Disagree	Strongly disagree
Science can prove the greatness of God in the creation of nature	56.40	33.00	7.60	3.00
Nature is evidence of the greatness of God in the creation of nature	59.60	28.70	8.60	3.20
The five senses and conscience are instruments to observe God's creation	55.60	33.80	7.60	3.00
An investigation is to prove the greatness of God in the creation of nature	50.51	33.33	14.14	2.02
Humans play a role and have a positive attitude towards nature as an act of worship to God Almighty	53.50	35.40	7.60	3.50
Average	54.10	31.80	9.70	4.40

This shows that most students strongly agree that (1) science can prove the greatness of God in the creation of nature; (2) nature is evidence of the greatness of God in the creation of nature; (3) the five senses and conscience are instruments to observe God's creation; (4) investigation is to prove the greatness of God in the creation of nature; (5) humans play a role and have a positive attitude towards nature as an act of worship to God Almighty. Most students strongly agree that science is a way to know the greatness of God's creation. They believe that the universe is a sign of the greatness of God's creation. Furthermore, they strongly agree that the senses, reason, and conscience (intuition/revelation and inspiration) of humans are valuable instruments for observing the creation of God Almighty. They also believe that the role and attitude of humans towards the universe is an act of worship to His Lord while the aspect of the investigation process to prove the greatness of God in the creation of nature obtains the lowest percentage of "Strongly agree". Only a few students do not believe that investigation is a process to show signs of the greatness of God Almighty. They do not fully believe that a scientist has the belief that investigating the universe is to prove the greatness of God.

This research shows that only a small number of students strongly disagree with this aspect. This shows that some students do not believe that investigation, in-depth analysis, and critical reasoning are intellectual processes to reach conclusions. They do not fully believe that religion encourages humans or scientists to research or study science to prove the greatness of God in the creation of the universe while the smallest number of students who disagree indicates that students have good faith in this aspect.

These results are in line with expert opinion, God commands humans to carry out scientific investigations, and to appreciate the greatness of God in the creation of nature (Sani, 2015) so that humans can use and manage it well (Khairuddin, 2021). Therefore, science and technology must be built on the right foundation, namely based on the world view of monotheism (Mannan, 2018). Thus, it is very important to instill spiritual values in science learning so that it can increase faith and piety to God through observing nature.

5 Conclusion

In general, students have a good understanding of NOS in subjectivity, creativity, socio-cultural closeness, empirical aspect, differences in observation and inference, scientific ethos, cooperation, and collaboration. However, they do not understand NOS well in the tentative aspect, scientific law and theory, and scientific method. They have good religious beliefs in obtaining scientific knowledge related to belief in God Almighty in the creation of the universe as signs of His power through the acquisition of knowledge, investigations, and using human senses so that humans play a role in protecting this nature as an act of worship to God. Although students have positive perceptions of religious beliefs in acquiring scientific knowledge, they should increase their beliefs, especially in the investigation process, to prove the greatness of God in the creation of nature and protect nature as an act of worship to God.

6 Availability of Data and Material

Data can be made available by contacting the corresponding author.

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