

STUDENTS' UNDERSTANDING OF NATURE OF SCIENCE IN ISLAMIC PRIVATE SCHOOL

Roswanna Safkolam

Faculty of Science Technology and Agriculture, Yala Rajabhat University
133 Thesaban 3, Sateng, Muang, Yala, Thailand, 95000
Email: roswanna.s@yru.ac.th

Prasart Nuangchalem*

Faculty of Education, Mahasarakham University
57XM+X3V, Talat, Mueang Maha Sarakham District, Maha Sarakham, Thailand, 44000
Email: prasart.n@msu.ac.th

R. Ahmad Zaky El Islami

Department of Science Education, Faculty of Teacher Training and Education,
Universitas Sultan Ageng Tirtayasa
Jl. Ciwaru Raya No.25 Cipocok Jaya, Kota Serang, Banten, Indonesia, 42117
Email: zakyslami@untirta.ac.id

Phurkhonni Saleah,

Faculty of Science Technology and Agriculture, Yala Rajabhat University
133 Thesaban 3, Sateng, Muang, Yala, Thailand, 95000
Email: phurkhonni.s@yru.ac.th

*Corresponding Author

Received: 11, 2022. Accepted: 06, 2023. Published: 06, 2023

ABSTRACT

The objective of this study is to explore Muslim students' level of understanding regarding the nature of science (NoS) and compare their understanding between genders in private Islamic schools in Thailand. Descriptive statistics and t-test independent was used to analyze the data. The results revealed that a majority of the participants held a transitional perspective on NoS. Furthermore, there were no statistically significant differences in NoS comprehension between genders at the .05 level. To enhance students' understanding of NoS in all domains, it is recommended that learning activities in private Islamic schools promote a reflective attitude towards NoS.

Keywords: Gender, Islamic Private School, Muslim student, Nature of Science, Science Learning.

ABSTRAK

Penelitian ini bertujuan mengeksplorasi tingkat pemahaman peserta didik Muslim tentang ilmu pengetahuan alam dan membandingkan pemahaman mereka antara gender berbeda di sekolah Islam swasta di Thailand. Statistik deskriptif dan uji-t independen digunakan untuk analisis data. Hasil penelitian menunjukkan, sebagian besar partisipan memiliki perspektif transisi tentang NoS. Selain itu, tidak ada perbedaan signifikan secara statistik dalam pemahaman NoS antara gender di tingkat signifikansi 0,05. Untuk meningkatkan pemahaman peserta didik tentang NoS di semua bidang, disarankan kegiatan pembelajaran di sekolah Islam swasta mendorong sikap reflektif terhadap NoS.

Kata Kunci: Gender, Pembelajaran Sains, Peserta Didik Muslim, Sekolah Islam Swasta, Sifat Ilmu Pengetahuan.

INTRODUCTION

Understanding the basic principles of scientific knowledge, the scientific method, and the social context in which science operates is a critical component of a well-rounded science education. Grasping the nature of science (NoS) is crucial for promoting scientific literacy, which is necessary for success in modern society. However, research suggests that students, including those who follow the Muslim faith, encounter obstacles in comprehending and acquiring knowledge about NoS. Specifically, Muslim students face significant challenges stemming from the cultural and religious norms they adhere to.

Muslim students face a range of challenges that impact their capacity to comprehend and acquire knowledge regarding the nature of science (NoS). These challenges encompass cultural and religious perspectives, language barriers, and insufficient science education. Within the context of Muslim students, their diverse cultural and religious beliefs can shape their understanding of science, natural history, and social history. For example, certain Muslim students may perceive a conflict between their religious beliefs and scientific principles, leading to difficulties in comprehending the role of science in contemporary society. Moreover, Muslim students who are non-native English speakers may encounter obstacles in effectively communicating their thoughts and ideas due to language barriers. Furthermore, a significant obstacle for Muslim students lies in the inadequate science education they receive, which hampers their understanding and learning of NoS.

In order for students to acquire knowledge in the field of science, it is important for them to have a solid grasp of the nature of science. The term "nature of science" encompasses the philosophy and methodology involved in acquiring and validating scientific knowledge. According to Afalo (2018), one key factor that facilitates students' understanding of science is their comprehension of the nature of science. By developing an accurate understanding of the nature of science, students not only gain significant scientific knowledge but also demonstrate understanding, cultivate interest, maintain a positive attitude towards science, and foster the ability to generate scientific knowledge. Furthermore, research conducted by Driver et al., (1996) and McComas et al., (2002) suggests that students' knowledge development in science is closely linked to their understanding and application of the principles governing the nature of science.

Muslim students encounter a significant obstacle in the form of a perceived conflict between science and religion, which can contribute to a diminished interest and negative attitude towards science. This conflict has the potential to generate both of these outcomes. Furthermore, the intricate and abstract nature of scientific concepts can pose difficulties for Muslim students in comprehending and applying scientific knowledge. Additionally, ineffective pedagogical methods used in science education can act as a barrier for Muslim students, as these approaches may not align with their religious and cultural backgrounds.

There are several strategies that can be employed to enhance the understanding of the NoS among Muslim students. These strategies encompass incorporating Islamic perspectives, utilizing appropriate educational methodologies, and fostering critical thinking skills. By integrating Islamic viewpoints into science classes, Muslim students can gain a deeper understanding of the compatibility between science and religion, dispelling the notion of an inherent conflict. Additionally, teaching NoS to Muslim students can be more effective when employing suitable methods such as providing real-life examples and engaging them in hands-on activities. Finally, by encouraging the development of critical thinking abilities, Muslim students can better evaluate scientific knowledge and comprehend the social context surrounding scientific research.

Despite the crucial role of understanding the nature of science in facilitating scientific learning, previous research indicates that students' comprehension of the subject is insufficient

and often flawed (Kim & Alghamdi, 2020; Widowati et al., 2018). Various factors significantly shape students' scientific knowledge, including the influence of teachers (Lederman & Druger, Dogan & Abd-El-Khalick, 2008), societal and cultural factors (Dogan & Abd-El-Khalick, 2008; Safkolam, 2020), and religious beliefs (Safkolam, 2020; Wan et al., 2013; Afalo, 2018). It should be noted that developing a curriculum solely aimed at enhancing scientific understanding within one culture has limited impact on students from other cultural backgrounds (Deng et al., 2014).

The southern border region of Thailand, comprising Pattani, Yala, and Narathiwat, is characterized by a multicultural society. The dominant religion in this region is Islam, resulting in a distinct society and culture that differs from other areas (Churngchow et al., 2015). To address the unique multicultural context, educational policies, often referred to as "multicultural education policies," have been implemented to accommodate the diverse learners in this region. These policies encompass various aspects such as the management of Islamic education, language policies, and other related initiatives (Arphattananon, 2018). In this region, schools, particularly private Islamic schools, play a significant role in the education of Muslim students, as parents actively choose to enroll their children in these institutions (Binsaleh & Binsaleh, 2020). As a result, schools in this area have gained increasing importance in the educational landscape.

The worldview of Muslim students in Thailand is significantly shaped by the teachings of Islam. It is likely that their religious beliefs and cultural practices influence their approach to and comprehension of science. Certain students may integrate Islamic principles with their scientific understanding, regarding science as a means to explore and marvel at the marvels of Allah's creation. However, in certain cases, there may be individuals who prioritize religious doctrines over scientific hypotheses, potentially leading to conflicts or tensions between religious and scientific perspectives. Within the Thai educational system, all students, irrespective of their religious background, are obligated to enroll in at least one science course.

The educational experiences and engagement of Muslim students in science education in Thailand can vary. Factors such as the availability of resources, community support, and teaching methodologies employed by educators can influence students' interest and comprehension of scientific concepts. Incorporating cultural and religious examples in science classes has the potential to enhance student engagement and encourage them to connect scientific knowledge with their own cultural and personal experiences.

The Ministry of Education is responsible for overseeing teaching and learning processes in Thailand and developing the curriculum for the country's basic education system. Private Islamic schools face challenges related to a lower standard of education specifically in Islamic studies-related subjects since the school year 2003 (Baka, 2011). National educational test results indicate that children from these schools generally obtain lower scores, with science scoring below the national average (Arphattananon, 2018). Additionally, it has been found that science teachers in these schools possess a lower level of expertise in areas such as media support and learning materials in science (Onsee & Nuangchalerm, 2019; Vasinayanuwatana et al., 2019).

Muslim students in Thailand encompass a diverse range of perspectives. Some individuals may perceive science as compatible with their faith, while others may perceive potential conflicts between certain scientific concepts and their deeply held beliefs. It is crucial to engage in open-minded discussions and interactions, appreciating the unique viewpoints of others, and striving to establish an inclusive environment that encourages communication and understanding of differing perspectives. Creating a welcoming atmosphere that nurtures scientific curiosity and critical thinking can benefit all children, provided that teachers and parents comprehend and value the various influences that shape their children's lives.

The Science Mathematics Program (SMP) is an initiative aimed at enhancing the teaching of science and mathematics in private Islamic schools located in the three southern border provinces. As part of this project, a science and mathematics laboratory has been established, equipped with necessary apparatus and learning materials to support scientific and mathematical activities in education. Furthermore, research conducted worldwide has explored the scientific abilities of Muslim students, as documented in studies by Dogan & Abd-el-Khalick (2008), Karakas (2017), and Kim & Alghamdi (2020).

Currently, there is a limited amount of research conducted in Thailand, particularly in relation to the nature of science within private Islamic schools. In particular, there is a lack of research that specifically focuses on students studying in specialized classrooms, such as those participating in the SMP, which provides additional science learning opportunities and resources compared to non-participating Islamic schools. Furthermore, the existing research primarily explores the influence of religious beliefs on students' understanding of the nature of science. Consequently, the research question arises: How do students enrolled in SMP in private Islamic schools comprehend the nature of science? Additionally, does gender have an impact on students' understanding of the nature of science, and if so, how does gender influence their understanding?

METHOD

In this investigation, a survey method was employed to examine the understanding of fundamental scientific inquiry among Muslim students. The details of the important technique and research approach are provided below.

Participants

The participants of this study were fourth-grade students enrolled in a special classroom within the SMP under the supervision of Yala Rajabhat University. The study included students from 12 private Islamic schools in Yala. A total of 210 fourth-grade students from the special classroom in the science SMP program were sampled for the study (Figure 1). The sampling process involved simple randomization and the calculation of sample numbers based on the method proposed by Krejcie and Morgan (1970).

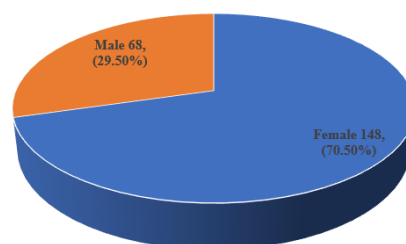


Figure 1. Informant Group

Research Instruments

The 24-question scientific nature understanding questionnaire utilized five estimation scales, employing a 5-point Likert scale: strongly agree, agree, uncertain, disagree, and strongly disagree. These scales were adapted from Safkolam (2020) and subsequently modified by the researchers. In order to address gender-related issues among students' responses regarding their understanding of the nature of science, the researchers included general information and adjusted certain questions pertaining to the natural characteristics of science. The research instruments comprehensively covers the nature of science across three domains: scientific worldview, scientific inquiry, and scientific enterprise. It measures six components: NoS 1: Scientific knowledge can be changed, NoS 2: Scientific knowledge requires empirical and verifiable evidence, NoS 3: Scientific methods are varied

and lack fixed procedures, NoS 4: Society and culture influence the work of scientists, NoS 5: Science is based on diverse observations and opinions, and NoS 6: Science relies on imagination and creative thinking. The content validity of the understanding nature of science questionnaire was determined by having three experts reviewing it. The result in validity index scores range from 0.67 to 1.00. Additionally, the questionnaire underwent a trial run with 30 students, and its reliability was calculated to be 0.81.

Data Collection

The researchers actively engaged in the SMP schools and administered a survey to assess the students' knowledge of the nature of science in private Islamic schools. Data was collected from 210 students using questionnaires specifically designed to measure the understanding of the nature of science. The data was subsequently analyzed by scoring and interpreting the responses based on the understanding nature of science framework proposed by Rubba and Andersen (1978), as presented in Table 1.

Table 1. Score to Assess Students' Understanding of Nature of Science

	Positive scale	Negative scale
Strongly agree	5	1
Agree	4	2
Not sure	3	3
Disagree	2	4
Strongly disagree	1	5

The completeness of the data was verified, and students were asked to respond to questions assessing their comprehension of scientific concepts. The data was then interpreted based on the average scores, as presented in Table 2 (Niyomwong, 2015). To evaluate the hypothesis, the researchers employed an independent t-test to compare the understanding of the nature of science between genders.

Table 2. Understanding Nature of Science by Group and Mean Score Level

Group	Guideline	Mean score level
Informed view	The description of the student corresponds to the natural characteristics of science, which is accepted all the present.	3.41-5.00
Transitional view	The description of the student corresponds to the natural characteristics of science, which is accepted today in part, but not entirely complete. The description of the student corresponds to the natural characteristics of science, which is partially accepted today and does not correspond to the natural characteristics of science, which is partially accepted.	1.71-3.40
Naïve view	The student's explanation does not correspond to the natural nature of all currently accepted sciences, or that questions are answered, do not match the question, or do not answer questions, nor do they make any comments at all.	Lower than 1.71

RESULTS AND DISCUSSION

A survey was conducted among students attending private Islamic schools to assess their understanding of the nature of science. The survey included 210 fourth-grade students from special classrooms in the Science and Mathematics Program (SMP), representing 12 private Islamic schools in Yala.

Findings from the questionnaires revealed that students held diverse perspectives on the nature of science. However, specific evidence indicated that students demonstrated a correct

understanding of certain aspects of the nature of science. For example, they recognized that scientists may discover more planets in the solar system in the future and that the theory of atoms is continuously evolving. They also understood that scientific knowledge requires verifiable evidence and that the acceptance of scientific findings is contingent upon supporting evidence. Furthermore, students recognized that scientists rely on observations, experiments, and interpretations to generate scientific knowledge. They acknowledged that different scientists may obtain varying results when observing the same subject due to their individual experiences. Students also understood that both observations and opinions are based on the five senses (eyes, ears, nose, tongue, and skin). Finally, they recognized that imagination and creativity play a role in explaining scientific knowledge as shown in Table 3.

Table 3. Percentage Indicating Nature of Science Comprehension

Item	Strongly agree (%)	Agree (%)	Not sure (%)	Disagree (%)	Strongly disagree (%)
Scientists may discover more planets in the solar system in the future	28 (13.3)	103 (48.4)	67 (31.5)	8 (3.8)	4 (1.9)
The theory of atoms is constantly studied and changing	28 (13.3)	84 (40.0)	70 (33.3)	21 (10.0)	7 (3.3)
Newton's law of motion has been accepted to date and none.	31 (14.8)	69 (32.9)	86 (41.0)	24 (11.4)	0 (0.0)
In the future, Mendel's hereditary rules could be debunked	16 (7.6)	56 (26.7)	99 (47.1)	33 (15.7)	6 (2.9)
Scientific knowledge requires verifiable evidence	95 (45.2)	99 (47.1)	14 (6.7)	2 (1.0)	0 (0.0)
The findings of scientists will only be accepted if there is evidence	89 (42.4)	100 (47.6)	19 (9.0)	21 (10.0)	7 (3.3)
The observational effect alone cannot be summarized as scientific knowledge	52 (24.8)	83 (39.5)	49 (23.3)	19 (9.0)	7 (3.3)
Discovery of scientific knowledge does not always require evidence	11 (5.2)	33 (15.7)	66 (31.4)	70 (33.3)	30 (14.3)
Scientists need observation, experiments and interpretations of scientific knowledge	65 (31.0)	125 (59.5)	19 (9.0)	1 (0.5)	0 (0.0)
Scientific methods can start with observations or problems first	52 (24.8)	116 (55.2)	29 (13.8)	12 (5.7)	1 (0.5)
Scientific knowledge is derived only from experiments	25 (11.9)	51 (24.3)	45 (21.4)	66 (31.4)	23 (11.0)
Scientific methods are definitely staged	66 (31.4)	113 (53.8)	26 (12.4)	4 (1.9)	1 (0.5)
One reason research into how perfume is extracted among Islamic scientists is so advanced. It is caused by Arab culture, preferring perfume	37 (17.6)	114 (54.3)	51 (24.3)	6 (2.9)	2 (1.0)
Scientists' experiments may pause If it's opposed by people in society	12 (5.7)	82 (39.0)	76 (36.2)	34 (16.2)	6 (2.9)
Scientists often work alone in laboratories	11 (5.2)	68 (32.4)	61 (29.0)	55 (26.2)	15 (7.1)
The beginning of the discovery of knowledge or the invention of scientific devices has nothing to do with the well-being and environment in the community of scientists	14 (6.7)	39 (18.6)	83 (39.5)	55 (26.2)	19 (9.0)
Science is based on observation and conclusion	33 (15.7)	130 (61.9)	38 (18.1)	8 (3.8)	1 (0.5)
Scientists' observations on the same subject may have different results because their experiences are different	55 (26.2)	119 (26.7)	30 (14.3)	4 (1.9)	2 (1.0)

Item	Strongly agree (%)	Agree (%)	Not sure (%)	Disagree (%)	Strongly disagree (%)
Observation is not the beginning of the discovery of scientific knowledge	11 (5.2)	34 (16.2)	67 (31.9)	62 (29.5)	36 (17.1)
Observations and commentary are no different because both characteristics require five senses (eyes, ears, nose, tongue and skin)	24 (11.4)	96 (45.7)	64 (30.5)	23 (11.0)	3 (1.4)
Dalton, a chemist, explained the atomic structure without experimenting, showing that he relied on imagination and creativity	16 (7.6)	75 (35.7)	90 (42.9)	27 (12.9)	2 (1.0)
Alfarizi, an Islamic physicist, experimented with the subject. Rainbow phenomenon using round glass instead of raindrops It shows that he relies on imagination and creativity to explain his knowledge of science	31 (14.8)	109 (51.9)	60 (28.6)	9 (4.3)	1 (0.5)
If scientists use imagination and creativity to explain knowledge, science will get the wrong information	11 (5.2)	71 (33.8)	99 (47.1)	24 (11.4)	5 (2.4)
Scientists will not use imagination and creativity to develop scientific knowledge	19 (9.0)	60 (28.6)	77 (36.7)	46 (21.9)	8 (3.8)

Some students expressed uncertainty or disagreement with certain statements regarding the nature of science. They were unsure about whether Newton's law of motion has remained unchanged over time and whether Mendel's hereditary rules may be debunked in the future. They also questioned the relevance of the well-being and environment in the scientific community to the discovery of knowledge or the invention of scientific devices. Additionally, students found it difficult to accept that Dalton, as a chemist, explained the atomic structure without conducting experiments, suggesting that he relied solely on imagination and creativity. Some students believed that if scientists use imagination and creativity to explain scientific knowledge, it could lead to misinformation. They also disagreed with the notion that scientists use imagination and creativity to develop scientific knowledge.

In terms of overall understanding, students demonstrated a level of disagreement with certain aspects of the nature of science. They disagreed with the statement that scientists often work alone in the laboratory. They also disagreed with the idea that the observational effect alone can be considered scientific knowledge. Furthermore, students did not perceive scientific methods to have an absolute hierarchy. On the other hand, they held the view that observations and opinions are not fundamentally different as both rely on the five senses (eyes, ears, nose, tongue, and skin). It is worth noting that the mean scores for each component of understanding the nature of science were relatively similar to one another (see Table 4).

Table 4. Characteristics nature of science

Component	\bar{X}	S.D.
NoS 1	3.11	0.40
NoS 2	3.58	0.53
NoS 3	3.27	0.42
NoS 4	3.32	0.45
NoS 5	3.44	0.44
NoS 6	3.17	0.48

Table 4 presents the mean scores for the component of the nature of science related to the requirement of empirical evidence in scientific knowledge. The mean scores in Tables 3 and 4

indicate that most students possess a transitional understanding of the nature of science. They have a proper understanding of the significance of empirical and verifiable evidence as the foundation of scientific practices.

While there may be some variations in students' perspectives on science, the majority of pupils hold a transitional viewpoint. During guided learning sessions led by teachers, certain topics may receive less attention or experimentation than others. These sessions provide opportunities for students to raise thought-provoking questions and engage in discussions, particularly regarding the more natural aspects of science (Nuangchalem, 2009; Nuangchalem, 2013). By answering questions and participating in self-reflection on the nature of science, students have the chance to deepen their understanding. This process of reflection and debate enhances the meaning and effectiveness of learning science (Yacoubian & Boujaoude, 2010). The ability to reflect, coupled with a solid comprehension of fundamental scientific concepts, is crucial (Khishfe & Abd-El-Khalick, 2002; Khishfe & Lederman, 2006; Prachagool & Nuangchalem, 2019a; Prachagool & Nuangchalem, 2019b).

Based on the data analysis, it was observed that certain students possess a comprehensive understanding of the judgments made by the scientific community. They recognize that scientific knowledge must be grounded in empirical evidence and subject to verification. This comprehension might be attributed to the educational practices students acquire in specialized classes, which emphasize scientific inquiry, hands-on learning, self-directed experiences, collaborative activities, and mastery of the scientific method (Parmin et al., 2019). As a result, students develop traits such as curiosity and a fascination for exploring the natural world. Teachers can provide opportunities for students to acquire knowledge through hands-on experiences. By engaging in scientific investigations, gathering evidence, conducting experiments, and employing scientific methodologies to solve problems, students achieve genuine learning and understanding of science (Widodo et al., 2019).

The significance of teaching science to children has long been recognized as a fundamental component of modern education. This is because students who study science are more likely to become informed and analytical adults. However, the relationship between scientific education and religious beliefs has been a subject of debate for centuries, particularly in countries with strong religious identities. Muslim students, in particular, often face challenges in reconciling their religious convictions with the study of science, perceiving a potential conflict between the two. Therefore, it is crucial to explore the beliefs of Muslim students regarding the nature of science (NoS) and understand how their religious convictions influence their perspectives on scientific inquiry.

Gender Comparison of Nature of Science Comprehension

When comparing the understanding of the nature of science based on gender at a significance level of 0.05, the analysis did not find any statistically significant difference. This suggests that there is no significant distinction in the comprehension of essential principles of scientific inquiry between male and female students.

Table 5. Comparison of Nature of Science Comprehension by Gender

Gender	n	\bar{X}	S.D.	t	p
Male	68	3.31	0.198	0.177	0.860*
Female	148	3.32	0.264		

*p < .05

Teachers have the opportunity to provide hands-on experiences to students, allowing them to acquire knowledge through direct engagement. This active approach to learning, involving the investigation of scientific hypotheses, the gathering of evidence, the execution of scientific procedures, and the application of scientific methodologies to solve problems, leads to actual learning and comprehension of science (Widodo et al., 2019). The results indicated a statistically

significant difference in the understanding of the fundamental principles of science between male and female students at the significance level of .05.

This difference in understanding could be attributed to the implementation of the national basic education curriculum, which guides the curriculum and teaching methods. The emphasis on scientific activities in scientific laboratories creates a learning environment that fosters the development of a scientific knowledge-seeking process among students (Emran et al., 2020). This approach is crucial for scientists to acquire scientific knowledge and serves as an effective tool for students to comprehend scientific procedures and methods (Fitriani et al., 2016). Consequently, students are able to establish connections between the content they learn in school and the research conducted by scientists (Crowther et al., 2005).

Furthermore, the approach taken by teachers in managing scientific learning can contribute to the problem. If the management style lacks clarity or precision regarding the nature of science, it can hinder students' understanding. It is important for teachers to adopt a perspective that aligns with the administration of scientific education at the national level, while also implementing educational activities that encompass the fundamental aspects of science and encourage inquiry. By engaging in activities that involve the process of acquiring scientific knowledge, such as conducting experiments in laboratories or participating in other inquiry-based activities, students can independently grasp the foundations of scientific inquiry. However, if natural scientific topics are not explicitly addressed or discussed in the classroom, and teachers rely solely on students' spontaneous understanding as they progress through science learning, it may hinder their comprehension of the nature of science (Abd-El-Khalick & Lederman, 2000a; Akerson et al., 2000; Khishfe & Abd-El-Khalick, 2002; Wanloh & Nuangchalerm, 2022).

Based on the research findings, scientists' perspectives on the nature of science are influenced by various societal and cultural factors. When students are educated in an Islamic context, there appears to be a considerable gray area in their understanding of the fundamental principles of science, as observed in a preliminary assessment (Kim & Hamdan, 2020). This may be attributed to the high value placed on perfumes in Arab culture. In contrast, previous correspondence has highlighted the tendency for scientists to work independently in laboratories. From a naïve perspective, the origin of knowledge discovery or the development of scientific tools within the scientific community was perceived as unrelated to the well-being and environment of that community, a notion that has been debunked by scientific consensus.

The nature of science (NoS) encompasses concepts such as the temporary nature of scientific knowledge, the use of empirical data, the significance of creativity and imagination, and the distinction between scientific hypotheses and theories. Previous research has demonstrated that students need a strong understanding of the NoS to further their scientific learning and enhance their critical thinking skills (Lederman, 2007). However, it has also been found that students often struggle to comprehend the NoS, and their level of understanding can be influenced by various factors, including their cultural and religious beliefs (Abd-El-Khalick & Lederman, 2000b).

According to Deng et al. (2014) and Afalo (2018), the development of a curriculum aimed at promoting a natural perspective of science in one culture does not significantly influence how students from another culture perceive the natural world. This is because students' societies and cultures heavily influence their perception of the natural world. Therefore, private Islamic schools in Thailand and other countries should focus on fostering an understanding of the nature of science and implementing learning strategies that reflect and align with the Islamic context of these nations. This is crucial to accommodate Islamic educational practices and adapt to the specific context of these countries.

The nature of science (NoS) encompasses the concepts and assumptions that form the basis of scientific inquiry. A solid understanding of the NoS is vital for promoting scientific

literacy and nurturing critical thinking skills. However, research has shown that students often struggle to grasp the NoS, and their comprehension can be influenced by various factors, including gender. Although gender is not considered one of the inherent characteristics of the NoS, it has been widely documented that male students tend to exhibit more positive attitudes towards science compared to their female counterparts. Gender differences in students' attitudes and beliefs about science have been extensively studied. Therefore, it is important to assess whether gender variations exist in how students comprehend the nature of science.

According to Abd-El-Khalick and Akerson (2004), the religious beliefs of Muslim students, which often shape their worldview, have an influence on their approach to and perception of scientific problems. Islam promotes the pursuit of knowledge and curiosity, as evident from the significant scientific contributions made by Muslim scholars during the Golden Age of Islam (Al-Hassan, 2001). Inquiry and the quest for knowledge are encouraged within the Islamic faith. However, there are instances where some people perceive a conflict between scientific study and religious beliefs, as illustrated by the ongoing debate between evolution and creationism (Akhtar, 2010). Therefore, it is crucial to explore how the religious perspectives of Muslim students impact their understanding of the fundamental principles of the scientific method.

To provide science teachers with a clear understanding of the nature of science, training activities should be designed to enhance their comprehension and guidance of scientific inquiry. This is particularly important for managing science education effectively. The study focused on a sample of students enrolled in SMP courses at private Islamic schools, serving as the subjects of the research. It is recommended to inform the relevant authorities and advocate for the development of a comprehensive understanding of the nature of science among students. Additionally, gathering data from this sample can facilitate a comparison of the level of scientific understanding between regular classrooms and specialized science classrooms.

The study on the relationship between the scientific method and Muslim students in Thailand has some gaps that need to be addressed. There is a lack of research specifically focusing on the nature of science and its implications for students who identify as Muslim in Thailand. Previous studies have primarily concentrated on understanding the foundational aspects of science among students from the general population. However, given the unique cultural and religious context in Thailand, it is crucial to consider how various factors within this context influence the scientific literacy of Muslim students. Additionally, most studies on the nature of science and scientific education in Thailand have been conducted in the Thai language, which may limit the accessibility of important findings for researchers from other countries.

Muslim students in Thailand represent a diverse range of backgrounds, and their previous exposure to science education may vary. It is essential to delve into these differences and explore how individuals' perspectives on science are influenced by their backgrounds. Incorporating Islamic perspectives in the teaching of the nature of science in Thailand should be considered to accommodate the unique viewpoints of Muslim students. This is particularly important as it allows them to approach scientific concepts through the lens of their religious beliefs. Furthermore, it is necessary to examine the extent to which the science education strategy in Thailand promotes understanding of the nature of scientific inquiry and meets the educational needs of Muslim students.

This study has several limitations. Firstly, the research relied solely on questionnaires to assess students' understanding of the nature of science, and it would have been beneficial to include a more comprehensive description of the nature of science to gather more detailed and informed data. Secondly, the findings revealed that the majority of students had a transitional view of understanding,

and only a few aspects aligned with an informed view, specifically recognizing that scientific knowledge requires empirical evidence and verification. Yala Rajabhat University, private education offices, and private Islamic schools should emphasize the promotion of understanding the nature of science among students. Thirdly, the participants in this study were specifically fourth-grade students from private Islamic schools, which may limit the generalizability of the findings to students from different educational settings. It is important to exercise caution when applying these findings to students with different characteristics or in different grade levels.

The present study proposes several recommendations. Firstly, considering that the majority of students have a transitional view of the nature of science (NoS), it is crucial to implement learning management approaches that facilitate a deeper understanding of NoS. This can be achieved through targeted strategies that foster knowledge and comprehension of the fundamental principles underlying scientific inquiry. Secondly, recognizing the significant role of teachers as change agents, it is important to organize training activities that enhance science teachers' understanding and management of NoS. These activities will equip teachers with a clear understanding of the nature of science, enabling them to effectively impart this knowledge to their students. Thirdly, while the study focused on SMP students in private Islamic schools, it is recommended to expand the investigation and compare the understanding of NoS between regular classrooms and special classrooms. This can be achieved by informing relevant authorities and collecting data from diverse educational settings.

Overall, further research is needed to deepen our understanding of the relationship between the nature of science and Muslim students in Thailand. This will enable the development of effective science education strategies that consider the influence of cultural and religious factors and cater to the specific learning requirements of Muslim students.

CONCLUSION

Based on the survey conducted, it was found that students generally possess accurate knowledge regarding scientific information, recognizing that it is based on empirical evidence and subject to verification. The majority of students demonstrate a transitional level of comprehension in regards to the NoS. Gender analysis indicates that there is no statistically significant distinction between male and female students in their understanding of NoS at a significance level of 0.05. Most students fall into the category of having a transitional understanding of NoS. Therefore, it is recommended to employ learning management systems that facilitate a deeper understanding of the characteristics and principles of the natural world. Teachers play a crucial role as both educators and agents of change in enhancing students' comprehension of the nature of science.

ACKNOWLEDGMENT

This research project is financially supported by Yala Rajabhat University and Mahasarakham University.

BIBLIOGRAPHY

- Abd-El-Khalick, F., & Akerson, V. L. (2004). Learning as Conceptual Change: Factors Mediating the Development of Preservice Elementary Teachers' Views of Nature of Science. *Science Education*, 88(5), 785-810. <https://doi.org/10.1002/sce.10143>
- Abd-EL-Khalick, F., & Lederman, N. G. (2000a). The Influence of History of Sciences Courses on Students' Views of Nature of Science. *Journal of Research in Science Teaching*, 37(10), 1057-1095. <https://doi.org/10.1002/1098-2736>.

- Abd-El-Khalick, F., & Lederman, N. G. (2000b). Improving Science Teachers' Conceptions of Nature of Science: A Critical Review of The Literature. *International Journal of Science Education*, 22(7), 665-701. <https://doi.org/10.1080/09500690050044044>
- Aflalo, E. (2013). Religious Belief: The Main Impact on The Perception of The Nature of Science on The Student Teachers. *Cultural Studies of Science Education*, 8(31), 623-641. <https://doi.org/10.1007/S11422-013-9504-9>.
- Akhtar, M. (2010). The Compatibility of Islam and Science: A Selective Bibliography. *Muslim World Journal of Human Rights*, 7(1), 1-34.
- Akerson, V. L., Abd-EL-Khalick, F., & Lederman, N. G. (2000). Influence of a Reflective Explicit Activity-Based Approach on Elementary Teachers' Conceptions of Nature of Science. *Journal of Research in Science Teaching*, 37(4), 295-317. [https://doi.org/10.1002/\(SICI\)1098-2736\(200004\)37:4%3C295::AID-TEA2%3E3.0.CO;2-2](https://doi.org/10.1002/(SICI)1098-2736(200004)37:4%3C295::AID-TEA2%3E3.0.CO;2-2)
- Al-Hassan, A. Y. (2001). *Science and Technology in Islam: Technology and Applied Sciences*. UNESCO.
- Arphattananon, T. (2018). *Multicultural Schools'': Thailand's Education Policy for Multicultural Society*. Bangkok: Chulalongkorn University.
- Baka, M. (2011). *The Integration of Contents and Learning Standards for The Level 3 of Islamic Private Schools in Southern Border Provinces of Thailand*. (Doctoral dissertation, Songkhlanakarin University).
- Binsaleh, S., Binsaleh, M. (2020). 4P-2E Model: Teaching and Learning Process through ICT Integration for Private Islamic Schools in Thailand. *Asian Journal of University Education*, 16(4), 71-81. <http://dx.doi.org/10.24191/ajue.v16i4.11944>.
- Churngchow, C., Rorbkorb, N., Petch-urai, O., Chirtkiatsakul, B, Waedramae, M, Saneeyeng, R, & Aumchoowattana, Y. (2015). A Model for the Development of the Teaching Efficiency of Religious Teachers in Islamic Private Schools in the Three Southernmost Provinces of Thailand, *Journal of Social Sciences Research*, 8(2), 1573-1585. <http://dx.doi.org/10.24297/jssr.v8i2.3726>.
- Crowther, D. T., Lederman, N. G., & Lederman, J. (2005). Understanding the True Meaning of Nature of Science. *Science and Children*, 43(2), 50-52. Retrieved from <https://eric.ed.gov/?id=EJ721620>
- Deng, F., Chai, C. S., Tsai, C-C, & Lin, T-J. (2014). Assessing South China (Guangzhou) High School Students' Views on Nature of Science A Validation Study. *Science & Education*, 23(4), 843-863. <http://dx.doi.org/10.1007/s11191-013-9674-6>
- Dogan, N. & Abd-El-Khalick, F. (2008). Turkish Grade 10 Students' Science Teachers' Conceptions of Nature of Science: A National Study. *Journal of Research in Science Teaching*, 45(10), 1083-1112. <https://doi.org/10.1002/tea.20243>
- Driver, R., John, L., Robin, M., & Scott, P. (1996). *Young Peopl's Images of Science*. Britstol: Open University press.
- Emran, A., Spektor-levy, O., Paz Tal, O., & Asaraf, O. (2020). Understanding Students' Perceptions of The Nature of Science in The Context of Their Gender And Their Parents' Occupation. *Science & Education*, 29, 237-261. <https://doi.org/10.1007/s11191-020-00103-z>.
- Fitriani, N. R., Widiyatmoko, A., & Khusniati, M. (2016). The Effectiveness of CTL Model Guided Inquiry-Based in Topic of Chemicals in Daily Life to Improve Student Learning Outcomes and Activeness. *Jurnal Pendidikan IPA Indonesia*. 5(2), 278-283. <https://doi.org/10.15294/jpii.v5i2.6699>.
- Karakas, M. (2017). Turkish Students' Views on Nature of Science. *European Journal of Education Studies*, 3(10), 176-183. <http://dx.doi.org/10.5281/zenodo.996574>.

- Lederman, N. G. (2007). Nature of Science: Past, Present, and Future. In S. K. Abell & N. G. Lederman (Eds.). *Handbook of research on science education* (pp. 831-879). Routledge.
- Lederman, N. G., Abd-El-Khalick, F., Bell, R. L., & Schwartz, R. S. (2002). Views of Nature of Science Questionnaire: Toward Valid and Meaningful Assessment of Learners' Conceptions of Nature of Science. *Journal of Research in Science Teaching*, 39(6), 497-521. <https://doi.org/10.1002/tea.10034>
- Lederman, N. G. & Druger, M. (1985). Classroom Factors Related to Changes in Students' Conceptions of The Nature of Science. *Journal of Research in Science Teaching*, 22(7), 649-662. <https://doi.org/10.1002/tea.3660220705>.
- McComas, W. F., Clough, M. P., & Almazroa, H. (2002). The Role and Character of The Nature of Science in Science Education. In W. F. McComas (Ed.), *The nature of science in science education* Netherlands: Kluwer Academic, pp. 3-40.
- Khishfe, R. & Abd-EL-Khalick, F. (2002). Influence of Explicit and Reflective Versus Implicit Inquiry-Oriented Instruction on Sixth Graders' Views of Nature of Science. *Journal of Research in Science Teaching*, 39(7), 551-578. <https://doi.org/10.1002/tea.10036>.
- Khishfe, R. & Lederman, N. G. (2006). Teaching Nature of Science Within a Controversial Topic: Integrated Versus Nonintegrated. *Journal of Research in Science Teaching*. 39(7), 395-418. <https://doi.org/10.1002/tea.20137>.
- Krejcie, R.V., & Morgan, D.W. (1970). Determining Sample Size for Research Activities. *Educational and Psychological Measurement*, 30(3), 607-610. <https://doi.org/10.1177/02F001316447003000308>.
- Kim, S. Y., & Hamdan Alghamdi, A. K. (2020). Saudi Arabian Secondary Students' Views of The Nature of Science Within Islamic Context. *International Journal of Science Education*, 42(13), 2266-2283. <https://doi.org/10.1080/09500693.2020.1818327>.
- Niyomwong, N. (2015). *Improving Teaching and Learning Process in Science and Technology for Society and Living (Sts) Course to Develop the Understanding of Nature of Science: A Participatory Action Research*. (Doctoral dissertation, Kasertsart University).
- Nuangchalerm, P. (2009). Preservice Teachers' Perception about Nature of Science. *The Social Sciences*, 4(5), 463-467. Retrieved from <https://eric.ed.gov/?id=ED505897>
- Nuangchalerm, P. (2013). Engaging Nature of Science to Preservice Teachers through Inquiry-Based Classroom. *Journal of Applied Science and Agriculture*, 8(3), 200-203.
- Onsee, P., & Nuangchalerm, P. (2019). Developing Critical Thinking of Grade 10 Students through Inquiry-Based STEM Learning. *Jurnal Penelitian dan Pembelajaran IPA*, 5(2), 132-141. <https://doi.org/10.3087010/jppi.v5i2.5486>.
- Parmin, P., Nuangchalerm, P., & El Islami, R. A. Z. (2019). Exploring the Indigenous Knowledge of Java North Coast Community (Pantura) Using the Science Integrated Learning (SIL) Model for Science Content Development. *Journal for the Education of Gifted Young Scientists*, 7(1), 71-83. <https://doi.org/10.17478/jegys.466460>.
- Prachagool, V., & Nuangchalerm, P. (2019a). Investigating the Nature of Science: An Empirical Report on the Teacher Development Program in Thailand. *Jurnal Pendidikan IPA Indonesia*, 8(1), 32-38. <https://doi.org/10.15294/jpii.v8i1.17275>.
- Prachagool, V., & Nuangchalerm, P. (2019b). Investigating Understanding the Nature of Science. *International Journal of Evaluation and Research in Education*, 8(4), 719-725. <https://doi.org/10.11591/ijere.v8i4.20282>.
- Safkolam, R. (2020). Usage of the History of Islamic Scientists to Enhance the Understanding of the Nature of Science of Seventh Grade Students In Islamic Private Schools. (*Doctor of Education, Srinakarinnvirot University*).

- Safkolam, R, Khumwong, P, Pruekpramool, C & Hajisamoh, A. (2020). Effects of Islamic Scientist History on Seventh Graders' Understandings of Nature of Science in a Thai Islamic Private School. *Jurnal Pendidikan IPA Indonesia*, 10(2), 282-291. <https://doi.org/10.15294/jpii.v10i2.26668>.
- Rubba, P. A. & Andersen, H. O. (1978). Development of an Instrument to Assess Secondary School Students' Understanding of The Nature of Scientific Knowledge. *Science Education*, 62(4), 449-458. <https://doi.org/10.1002/sce.3730620404>.
- Vasinayanuwatana, T., Ketsing, G., Pongsophon, P., & Chattham, M. (2019). Current State, Problem, Need and Readiness for Stem Education in Islamic Private Schools. *Journal of Education, Prince of Songkla University, Pattani Campus*, 30(1), 96-109.
- Wan, Z. H., Wong, S. L., & Zhan, Y. (2013, May). When Nature of Science Meets Marxism: Aspects of Nature of Science Taught by Chinese Science Teacher Educators to Prospective Science Teachers. *Science & Education*, 22(5), 1115-1140. <https://doi.org/10.1007/S11191-012-9504-2>.
- Wanloh, S., & Nuangchalerm, P. (2022). Developing Scientific Explanation of Grade 10 Biology Students through Sociobiological Case-Based Learning. *International Online Journal of Education and Teaching*, 9(3), 1086-1095.
- Widodo, E., Widowati, A., & Setyaningsih, A. (2019). The Effectiveness of Nature of Science (NOS) Within Guided Inquiry Learning Approach for Developing Students' Scientific Literacy in Junior High School. *Journal of Physics: Conference Series*, 1321, 1-5. <http://dx.doi.org/10.1088/1742-6596/1321/3/032071>.
- Widowati, A., Atun, S., Suryadama, IGP., Wiyarsi, A., & Yani, L. (2018). The Profile of Students' Views of Nature of Science (NOS) in Junior High School of Yogyakarta City. *Paper presented at the International Conference on Science and Applied*. 020092, 1-7. <https://doi.org/10.1063/1.5054496>.
- Yacoubian, H. A. & Boujaoude, S. (2010) . The Effect of Reflective Discussions Following Inquiry-Based Laboratory Activities on Students' Views of Nature of Science. *Journal of Research in Science Teaching*, 47(10), 1229-1252. <https://doi.org/10.1002/tea.20380>.