Habits of Mind of Prospective Science Teachers: Exploring Cognitive Dispositions in Designing Science-Based Halal Products

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ABSTRACT

This study aimed to map the Habits of Mind profiles of prospective science teachers in designing science-based halal products. The research employed a quantitative descriptive survey design involving prospective science teachers who had completed courses related to science and product development. Data were collected using a validated Habits of Mind questionnaire encompassing key dimensions such as persistence, flexible thinking, metacognitive thinking, applying past knowledge to new situations, questioning and problem posing, and striving for accuracy. Descriptive statistical analyses, including means, and categorical classifications, were conducted to determine the levels of students' Habits of Mind. The findings revealed that the overall Habits of Mind of prospective science teachers were categorized as moderate and high. The strongest dimensions were thinking flexibly, thinking about thinking (metacognition), and applying past knowledge to new situations, indicating that students were capable of adapting scientific concepts to the development of halal products. However, several dimensions, particularly questioning and problem posing as well as striving for accuracy, and taking responsible risks showed relatively lower scores and require further enhancement through instructional interventions. These findings provide valuable insights into the cognitive dispositions of prospective science teachers and underscore the importance of integrating Habits of Mind-oriented learning experiences into science teacher education programs. Such efforts may better prepare future science teachers to engage in

innovative, scientifically grounded, and ethically responsible halal product development.

Keywords: Habits of Mind, Prospective science teachers, Halal products, Science-based product design, Science education.

INTRODUCTION

The demands of 21st-century education require prospective teachers to possess not only strong content knowledge but also higher-order thinking dispositions that enable them to solve complex and contextual problems (Yulianto et al., 2019; Sun, 2018; Wang et al., 2023). In science education, the development of cognitive dispositions has become increasingly important because science learning is closely related to inquiry, problem-solving, innovation, and decision-making processes (Kwok, 2018; Costa et al., 2023). Prospective science teachers are therefore expected to demonstrate productive thinking behaviours that support scientific reasoning and the application of knowledge in real-life situations (Wang et al., 2023; Costa et al., 2023). One of the constructs that has gained considerable attention in this context is Habits of Mind (HoM), which refers to intelligent behaviours employed when individuals encounter problems whose solutions are not immediately apparent (Costa & Kallick, 2023). Costa and Kallick conceptualized Habits of Mind as patterns of intellectual behaviour that lead individuals to productive actions, including persistence, flexible thinking, metacognitive thinking, questioning and problem posing, applying past knowledge to new situations, and striving for accuracy (Costa & Kallick, 2008). These dispositions are considered essential for developing effective problem solvers and lifelong learners.

In science teacher education, Habits of Mind play a crucial role in preparing future educators who are capable of facilitating meaningful learning experiences and fostering critical thinking among students (Costa & Kallick, 2008; Ritchhart, 2002). Previous studies have shown that prospective science teachers need strong self-regulation, creative thinking, and critical thinking abilities as integral components of Habits of Mind (Marzano, 1998; Facione, 2015; Zohar & Dori, 2012). Research conducted among prospective biology teachers revealed that the majority of students demonstrated adequate levels of Habits of Mind, indicating that these cognitive dispositions are important indicators of teacher readiness in science education (Nursa'adah et al., 2021; Fuad et al., 2017). Furthermore, the cultivation of Habits of Mind has been recognized as a significant factor in supporting teacher growth, reflective practice, and professional

development (Costa & Kallick, 2008; Schön, 1983). Educational environments that intentionally nurture these habits can encourage teachers to become more adaptive, innovative, and responsive to changing educational demands (Darling-Hammond et al., 2020; Fullan, 2020).

The importance of Habits of Mind becomes even more evident in learning contexts that require interdisciplinary integration and authentic problem-solving (Costa & Kallick, 2008; Pellegrino & Hilton, 2012). Contemporary science education emphasizes the development of higher-order thinking skills, including critical thinking, creative thinking, scientific reasoning, and problem-solving abilities (National Research Council, 2012; OECD, 2023). These competencies are necessary for addressing increasingly complex scientific and societal issues (OECD, 2023; Bybee, 2013). Several studies have highlighted the effectiveness of inquiry-based and higher-order thinking-oriented learning approaches in enhancing students' cognitive skills and scientific literacy (Lazonder & Harmsen, 2016; Furtak et al., 2012; Hwang et al., 2022). Consequently, prospective science teachers must develop thinking dispositions that allow them to analyze problems critically, generate innovative ideas, and make evidence-based decisions (Costa & Kallick, 2008; Facione, 2015; Zohar & Dori, 2012).

One contextual issue that provides meaningful opportunities for the development of Habits of Mind is the design of halal products based on scientific principles (Costa & Kallick, 2008; Hashim et al., 2024). The rapid growth of the global halal industry has expanded the demand for products that meet both scientific quality standards and halal requirements (Azam & Abdullah, 2020; Harsanto et al., 2026). Halal products are no longer limited to food and beverages but also include cosmetics, pharmaceuticals, biotechnology products, and various consumer goods (Azam & Abdullah, 2020; Noviyanti & Hakim, 2025). Designing halal products requires individuals to integrate scientific knowledge, ethical considerations, creativity, and analytical thinking to ensure that products comply with halal principles while maintaining quality, safety, and functionality (Belkhatir et al., 2020; Hashim et al., 2024). For prospective science teachers, engagement in science-based halal product design can serve as an authentic learning experience that promotes scientific inquiry, innovation, and contextual problem-solving (Pellegrino & Hilton, 2012; Bybee, 2013; Hashim et al., 2024).

Despite the increasing relevance of halal science and product innovation in education, studies examining the cognitive dispositions of prospective science teachers in this context remain limited (Hashim et al.,

2024; Wiyarsi et al., 2023). Existing research has primarily focused on measuring Habits of Mind in general science learning settings, while investigations into how these dispositions are manifested during science-based halal product design are still scarce. Most studies have explored Habits of Mind from the perspectives of academic achievement, critical thinking, or general science competencies without specifically addressing the integration of science and halal product development (Gloria et al., 2017; Ariyati & Fitriyah, 2024). This indicates a gap in the literature regarding the readiness of prospective science teachers to apply their thinking dispositions in interdisciplinary and culturally relevant contexts (Wiyarsi et al., 2023).

Furthermore, teacher education programs increasingly emphasize the need to prepare future educators who are capable of connecting scientific knowledge with societal needs and local values OECD, 2023; Wiyarsi et al., 2023). Developing science-based halal products represents a learning context that aligns with these objectives because it encourages students to apply scientific concepts while considering ethical, religious, and consumer-related dimensions (Al-Zahro et al., 2024; Bybee, 2013). Understanding the profile of prospective science teachers' Habits of Mind in this context is therefore important for designing instructional strategies that strengthen cognitive dispositions and support innovative thinking (Costa & Kallick, 2008; Wiyarsi et al., 2023).

Several previous studies have investigated the profile and development of Habits of Mind among prospective teachers. Gloria et al. (2017) examined the Habits of Mind of prospective biology teachers and found that most participants demonstrated moderate to high levels of cognitive dispositions, particularly in curiosity and reflective thinking. However, the study focused primarily on general academic contexts and did not explore how these dispositions were manifested in authentic product-design activities. Similarly, Wiyarsi et al. (2023) investigated Indonesian prospective teachers' scientific habits of mind in relation to local and global socio-scientific issues. Their findings indicated that exposure to socio-scientific issues influenced the development of scientific habits of mind and supported decision-making processes. Nevertheless, the study emphasized socio-scientific issue contexts and did not address innovation-oriented activities such as product development or entrepreneurship-based science learning.

Other studies have focused on measuring or developing Habits of Mind instruments among prospective teachers. For example, Kurniasih et

al. (2022) employed Rasch analysis to investigate the Habits of Mind of pre-service mathematics teachers, while Ubaidillah et al (2022) developed a Habits of Mind instrument within the context of physics laboratory activities. These studies contributed significantly to the assessment of cognitive dispositions; however, their primary focus was methodological rather than contextual, providing limited insights into how Habits of Mind function in interdisciplinary learning environments.

In addition, research on halal literacy and halal-oriented science education has begun to emerge. Al-Zahro et al. (2024), for instance, proposed a problem-solving-based science learning design incorporating halal literacy to enhance students' understanding of additives and addictive substances. While this study demonstrated the educational potential of integrating halal perspectives into science learning, it did not investigate the cognitive dispositions of prospective teachers or their readiness to design halal products based on scientific principles

A review of the existing literature reveals three important gaps. First, previous studies predominantly investigated Habits of Mind in general science learning, laboratory activities, or socio-scientific issue contexts, with limited attention to science-based halal product design. Second, although halal literacy has increasingly been integrated into science education, studies examining the thinking dispositions of prospective science teachers within halal product development remain scarce. Third, there is a lack of empirical evidence describing the profile of prospective science teachers' Habits of Mind when they are required to integrate scientific knowledge, creativity, ethical considerations, and halal principles into a product-design process.

Therefore, this study addresses these gaps by mapping the Habits of Mind of prospective science teachers in designing science-based halal products. Unlike previous studies that focused on classroom learning, laboratory activities, or socio-scientific issues, the present research situates Habits of Mind within an authentic and interdisciplinary context that combines science education, halal literacy, and innovation. The novelty of this study lies in its examination of Habits of Mind within the emerging field of science-based halal product design, providing a new perspective on how prospective science teachers apply cognitive dispositions when engaging in innovation-oriented and culturally relevant scientific practices. The findings are expected to contribute to the development of science teacher education programs that foster higher-order thinking, scientific innovation, and halal literacy simultaneously.

METHOD

This study employed a quantitative descriptive research design to map the Habits of Mind profiles of prospective science teachers in designing science-based halal products. A descriptive survey approach was utilized to obtain a comprehensive overview of students' cognitive dispositions as reflected in their responses to various Habits of Mind indicators. The study did not aim to determine causal relationships among variables but rather to describe the level and distribution of Habits of Mind among the participants. The participants of this study were undergraduate students enrolled in the Science Education (Tadris IPA) program at UIN Sunan Kudus, Indonesia. The participants were selected using purposive sampling based on the criterion that they had completed science-related courses and participated in learning activities involving the design of science-based halal products. A total of 72 prospective science teachers participated in the study. Data were collected using a Habits of Mind Questionnaire adapted from the framework developed by Costa and Kallick (2008). The questionnaire consisted of indicators representing selected dimensions of Habits of Mind considered relevant to science-based halal product design, including: (1) Persistence (persisting); (2) Managing impulsivity; (3) Thinking flexibly; (4) Thinking about thinking (metacognition); (5) Applying past knowledge to new situations; (6) Questioning and problem posing; (7) Gathering data through all senses; (8) Creating, imagining, and innovating; (9) Taking responsible risks; (10) Striving for accuracy. The questionnaire employed a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). Prior to data collection, the instrument was subjected to expert validation involving science education and educational measurement specialists. Reliability analysis was conducted using Cronbach's Alpha coefficient to ensure internal consistency.

The study was conducted during the implementation of a science-based halal product design project. Students were assigned to identify a potential halal product, analyze its scientific principles, evaluate halal compliance, and propose an innovative product design. Following the completion of the project, participants completed the Habits of Mind questionnaire electronically. The collected data represented students' self-reported cognitive dispositions while engaging in the design process. Participation was voluntary, and informed consent was obtained from all participants prior to data collection. Data were analyzed using descriptive statistics, including mean scores, standard deviations, percentages, and category classifications. The mean scores of each Habits of Mind dimension were calculated to determine students' levels of cognitive dispositions.

The categorization of Habits of Mind levels was adapted from the following criteria:

Table 1:
Criteria Habits of Mind Levels

Mean score	Category
4.21 – 5.00	Very high
3.41 – 4.20	High
2.61 – 3.40	Moderate
1.81 – 2.60	low
1.00 – 1.80	Very low

The results were presented descriptively through tables and graphs to provide a comprehensive profile of prospective science teachers' Habits of Mind in designing science-based halal products. Additionally, comparisons among the dimensions were conducted to identify the strongest and weakest cognitive dispositions demonstrated by the participants. This study adhered to ethical research principles, including voluntary participation, confidentiality of participants' identities, and the use of data solely for academic purposes. Participants were informed about the objectives of the study and were assured that their responses would remain anonymous.

FINDINGS AND DISCUSSION

The analysis of prospective science teachers' Habits of Mind was conducted across ten dimensions adapted from Costa and Kallick's framework. The findings revealed that the overall level of Habits of Mind among participants was categorized as **high** (M = 3.69), indicating that prospective science teachers demonstrated productive thinking dispositions while designing science-based halal products.

Table 1:
Profile of Prospective Science Teachers' Habits of Mind

Habits of Mind Dimension	Mean	Category
Persistence	4.10	high
Managing Impulsivity	3.38	moderate
Thinking Flexibly	4.15	high
Thinking About Thinking (Metacognition)	4.12	high
Applying Past Knowledge to New Situations	4.18	high
Questioning and Problem Posing	3.18	moderate

Gathering Data Through All Senses	3.33	moderate
Creating, imagining, and innovating	4.07	high
Taking Responsible Risks	3.24	moderate
Striving for Accuracy	3.21	moderate
	3.69	**high**

The findings indicate that the highest score was obtained in the dimension of applying past knowledge to new situations (M = 4.18), followed by thinking flexibly (M = 4.15) and thinking about thinking (metacognition) (M = 4.12). meanwhile, the dimensions of questioning and problem posing (M = 3.18), striving for accuracy (M = 3.21), and taking responsible risks (M = 3.24) demonstrated comparatively lower scores, although they remained within the moderate category.

The findings suggest that prospective science teachers possess relatively strong Habits of Mind in the context of designing science-based halal products. This result indicates that students were able to employ productive intellectual behaviours while engaging in authentic scientific and innovation-oriented tasks. According to Costa and Kallick (2008), Habits of Mind represent patterns of intelligent behaviour that individuals utilize when confronted with situations in which solutions are not immediately available. The process of developing halal products requires students to integrate scientific concepts, evaluate halal compliance, generate innovative ideas, and make informed decisions, thereby activating various dimensions of Habits of Mind simultaneously.

One of the most prominent findings was the high score in applying past knowledge to new situations. This finding indicates that prospective science teachers were capable of transferring previously acquired scientific knowledge into new and authentic contexts. During the product-design process, students utilized concepts from chemistry, biology, food science, and environmental science to analyze ingredients, production methods, and halal-related considerations. Such knowledge transfer reflects meaningful learning and demonstrates students' ability to connect theoretical understanding with practical applications.

This finding is consistent with Gloria et al. (2017), who reported that prospective biology teachers exhibited strong tendencies to utilize prior knowledge in solving scientific problems. The authors emphasized that Habits of Mind facilitate the application of scientific understanding in unfamiliar situations and contribute to effective problem-solving abilities. Similarly, Costa and Kallick (2008) argued that applying prior knowledge is

a key characteristic of intelligent behaviour because it enables learners to construct new understandings based on previous experiences.

Another important finding concerns the high level of thinking flexibly. Flexibility in thinking is essential when students are required to consider multiple perspectives and alternative solutions. Designing halal products involves not only scientific feasibility but also ethical, religious, consumer, and sustainability considerations. Consequently, students must continuously adapt their ideas and evaluate different possibilities throughout the innovation process.

The finding supports previous studies emphasizing that flexible thinking contributes significantly to creativity and innovation. According to Wiyarsi et al. (2023), exposure to socio-scientific issues encourages prospective teachers to evaluate problems from multiple viewpoints and develop reflective judgments. In the present study, students demonstrated similar cognitive flexibility when evaluating halal ingredients, modifying product formulations, and considering consumer needs. Such abilities are particularly important in science education because real-world scientific problems rarely have single or straightforward solutions.

The dimension of thinking about thinking (metacognition) also showed a high score, indicating that participants actively monitored and evaluated their cognitive processes. Metacognitive thinking enables individuals to plan, regulate, and assess their strategies while solving problems (Flavell, 1979; Schraw & Moshman, 1995). During product development, students were required to verify scientific information, evaluate the credibility of references, monitor project progress, and revise their decisions when necessary (Zimmerman, 2002; Schraw & Dennison, 1994). These activities reflect the presence of metacognitive awareness in the learning process.

This finding aligns with the work of Schraw and Dennison (1994), who highlighted metacognition as a critical component of self-regulated learning and effective problem-solving. Likewise, Saptono et al. (2016) found that higher-order thinking activities supported prospective teachers' ability to reflect on their learning processes and make informed decisions. Therefore, the integration of product-design projects into science learning appears to provide meaningful opportunities for the development of metacognitive dispositions (Pellegrino & Hilton, 2012; Hmelo-Silver, 2004).

The relatively high score in Creating, Imagining, and Innovating further suggests that students were able to generate original ideas and develop creative solutions. Product design inherently requires creativity

because students must identify potential problems, propose innovative products, and adapt scientific principles to practical applications. The halal product context may have stimulated creativity by challenging students to combine scientific innovation with halal requirements and consumer expectations.

This finding supports contemporary views of science education that emphasize innovation as an essential twenty-first-century competency. According to the Partnership for 21st Century Learning, creativity and innovation are critical skills required for addressing future societal challenges. Through halal product design activities, students not only learned scientific concepts but also practiced transforming those concepts into tangible innovations.

Despite the generally positive findings, the dimensions of questioning and problem posing, striving for accuracy and taking responsible risks showed comparatively lower scores. This result suggests that students may still experience difficulties in generating critical questions or exploring uncertain possibilities during the innovation process. Such tendencies are understandable because many educational environments continue to emphasize correct answers rather than exploratory inquiry.

The lower achievement in questioning skills and striving for accuracy are consistent with findings reported by Gloria et al. (2017), who noted that prospective teachers often demonstrate stronger performance in knowledge application than in formulating investigative questions. However, questioning is a fundamental aspect of scientific inquiry because it drives exploration, experimentation, and knowledge construction. Consequently, science teacher education programs should provide more opportunities for students to engage in inquiry-based and problem-based learning activities that encourage question generation and critical investigation.

Similarly, the relatively lower score in taking responsible risks indicates that students may still hesitate to test unconventional ideas or explore innovative solutions that involve uncertainty. Innovation-oriented learning requires learners to tolerate ambiguity and accept the possibility of failure as part of the learning process. According to Costa and Kallick (2008), responsible risk-taking is a characteristic of intelligent behavior because it encourages individuals to move beyond familiar patterns and discover new possibilities. Therefore, learning environments should be designed to support experimentation, reflection, and iterative improvement. Overall, the findings demonstrate that science-based halal

product design provides an authentic learning environment that supports the development of Habits of Mind. The activity encourages students to integrate scientific knowledge, creativity, critical thinking, ethical reasoning, and innovation into a single learning experience. Unlike traditional classroom activities that often emphasize conceptual understanding alone, product-design projects require students to apply knowledge in realistic situations and address complex interdisciplinary challenges.

Furthermore, this study contributes to the existing literature by extending Habits of Mind research into the emerging domain of halal-oriented scientific innovation. Previous studies primarily focused on classroom instruction, laboratory learning, psychometric assessment, or socio-scientific issue discussions. In contrast, the present study demonstrates that halal product development can function as a meaningful context for fostering productive thinking dispositions among prospective science teachers. The integration of science education, halal literacy, and innovation-based learning therefore represents a promising approach for preparing future educators who are capable of addressing both scientific and societal needs in the of 21st-century.

CONCLUSION

The findings revealed that most participants were categorized at a high level of Habits of Mind, indicating that they possess productive thinking dispositions that support problem-solving, creativity, and scientific decision-making. The strongest dimensions were applying past knowledge to new situations, thinking flexibly, and thinking about thinking (metacognition), suggesting that prospective science teachers are able to transfer scientific knowledge to authentic contexts and reflect on their thinking processes during product development activities. However, the dimensions of questioning and problem posing, striving for accuracy, and taking responsible risks showed relatively lower levels and therefore require further improvement.

These findings indicate that science-based halal product design can serve as a meaningful learning context for developing Habits of Mind among prospective science teachers. The integration of scientific knowledge, halal literacy, and innovation-oriented activities provides opportunities for students to develop higher-order thinking skills and real-world problem-solving abilities. Therefore, science teacher education programs should incorporate project-based and contextual learning experiences to strengthen students' cognitive dispositions and prepare them to address

future scientific and societal challenges. Overall, the study suggests that preparing future science teachers requires not only mastery of scientific knowledge but also the cultivation of productive thinking dispositions that enable them to transform knowledge into innovative and socially relevant solutions. Science-based halal product design offers a promising pathway for achieving this goal by connecting science learning with real-world needs, ethical values, and sustainable innovation.

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