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Exploring Decision-Making Skills in Science Education: A Systematic Review of Operational Definition and Instructional Trends

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Abstract

Decision-making skills are widely recognized as essential for preparing students to navigate complex societal and scientific issues, yet how these skills are defined and taught in science education remains fragmented. This systematic review examined 20 studies published between 2010 and 2025 to analyze how decision-making is defined and what components are emphasized, how the criteria of decision is developed, and the kind of instruction supports its development. The PRISMA selection process identified eight key components of decision-making: identify problem, collect scientific data and evidence, consider multiple perspectives, generate options, develop criteria, assess pros and cons, select and justify decision, and evaluate decision. The review revealed that developing criteria, one component of decision-making, often involves developing values-based criteria. Learning practices were dominated by discussions, group work, and worksheets, with limited use of simulations, debates, or digital tools. These findings provide a framework for understanding and teaching decision-making skills in science education. Future research should validate this framework in classroom contexts and explore its adaptability across diverse educational environments.

Keywords: Decision-making skills, Conceptual framework, Instructional practices, Teaching materials, Science education

INTRODUCTION

Decision-making skills are one of the essential competencies that students must possess to face future challenges. PISA 2025 Science Framework emphasized that key educational outcomes for students to engage with science-related issues, with the ideas of science, and to use them for informed decision making. Additionally, OECD highlighted the necessity of stressing the significance of developing such competencies that would help people to make an informed decision in a complicated situation (OECD, 2022). The concept of making an informed decision means making a decision that is supported and consistent with evidence and not driven by feelings or past experiences (Khishfe, 2012).

Decision-making as a skill is integral to general education (Kortland, 1996; Luan et al., 2022; Mettas, 2011). The reason being that decision-making involves cognitive and meta-strategic skills which do not come into play naturally without training (Hsu & Lin, 2017). Ethical dilemmas in biology, environmental policymaking, and even technology have made it necessary for citizens to have skills of analyzing problems and coming up with justifiable decisions (Gutierez, 2015). Therefore, strengthening students' decision-making competence has become a global education priority. Decision-making skill is not just about making choices, but involves multiple components.

Many studies have examined the decision-making skills and have identified several key components that should be considered. However, despite the growing body of research, some studies focus only on selected aspects. Those interested in argumentation quality may concentrate on how students assess pros and cons or justify a decision (Cetinkaya & Saribas, 2023; Dawson & Venville, 2010; Rathouská et al., 2021), while others focus on trade-offs and strategies (Jimenez et al., 2024; Papadouris, 2012) . However, understanding all essential components of decision-making is important. Focusing on selected components may make it difficult to fully represent the complexity of decision-making and may constrain how students' decision-making skills are supported.

Several previous studies have attempted to construct components for decision-making skills (Grace, 2009; Lee, 2007; Ratcliffe, 1997; Sadler & Zeidler, 2005; Yang, 2004; Zoller, 1982) . While these early studies share certain components, such as generating options, developing criteria, and weighing alternatives, they differ substantially in scope and complexity. Most early work emphasized reasoning about options and justifying choices, whereas fewer studies examined components such as recognizing stakeholder perspectives and reflection on the decision that has been made. The development of criteria, for instance, is an integral part of the decision-making process. Criteria are defined in terms of what is important (e.g., ecological consequences, financial considerations, feasibility), and how options will be evaluated. This phase affects the entire course of analysis and thus needs to be taken into account by students. Yet, not all studies explicitly operationalize this component.

Prior research shows that students rarely develop criteria arbitrarily. Instead, their criteria emerge from the perspectives they adopt, and the contextual information available to them (Lee & Grace, 2012) found that students formed criteria based on the stakeholder perspectives they took. Similarly, Hsu & Lin (2017) demonstrated that students developed criteria by integrating multidimensional information. In addition, students' educational backgrounds shape the types of criteria they construct Nahum et al., 2010) . Together, these studies highlight that constructing decision criteria requires students to integrate evidence, perspectives, values, and contextual knowledge before weighing alternatives.

Education is not only about delivering content knowledge but also serves as a platform to help students master decision-making skills. Science content, particularly when embedded in socioscientific issues (SSI), can be used as a meaningful context for students to practice making reasonable decisions. Using SSI as the context may develop students' ability to engage with real-world issues that have scientific, social, and moral dimensions, and ethical dimensions Gutierez, 2015; Jho et al., 2014) . SSI are typically controversial and require individuals to make decisions that weigh scientific data, personal beliefs, and societal consequences (Lee et al., 2013) . Socioscientific issues include climate change, food and energy scarcity (Zaikauskaite et al., 2020) , as well as biodiversity loss and sustainable development, which are complex issues related to society, science, and technology (Kinslow et al., 2019; Y. C. Lee, 2007; Sutter et al., 2019a) . It means decision-making skills have a wide chance to be achieved through the science learning process.

Several literature reviews have examined decision-making within SSI context, providing a similarly valuable foundation for understanding its role in science education. Recent reviews, such as those by Dewi & Yahdi (2025) and Chaniotou et al. (2025) , have largely focused on the outcomes, highlighting improvements in argumentation, problem solving, scientific literacy, and informed decision-making. Högström et al. (2025) provided a broad overview of SSI teaching methods. Earlier theoretical work by Sadler (2004) and Jho (2015) established the structural framework.

However, despite these contributions, there are gaps in how these components are translated into practice. First, there remains considerable variation in how decision-making skills are conceptualized and operationalized across studies. Recent emphasis on considering multiple perspectives suggests a need to extend beyond earlier component models to capture the complexity of decision-making. Second, while criteria are acknowledged as essential, there is limited synthesis regarding how students develop and construct these criteria. Finally, while broad SSI teaching methods have been reviewed, there is a limited amount of specific data regarding the trends of instructional practices and materials explicitly utilized for decision-making.

Therefore, the aims of this study are: (1) to define and conceptualize decision-making skills in science education, (2) to explore how students develop and construct decision criteria, and (3) to examine the trends of instructional practices and teaching materials utilized in the literature to support decision-making skills in science education. By integrating these three dimensions into a single synthesis, this review offers a more comprehensive understanding of decision-making in science education. Overall, this review aims to provide empirically grounded insights that can inform instructional design and support educators in fostering students' decision-making skills in practice.

METHOD

Literature Search and Selection

This systematic review was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) guidelines (Moher et al., 2009). Relevant

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articles were searched from three major databases: Scopus, ERIC, and Google Scholar. The search was conducted from October 2024 to March 2025. The following keywords were used: *decision making skills in science education, measuring decision-making skills, decision-making skills, decision-making* in ERIC and Google Scholar. For Scopus database, the following keywords and Boolean operators were used: *"decision making skills" OR "decision making" OR "decision-making" AND "science education"*. The article selection process is summarized in Figure 1.

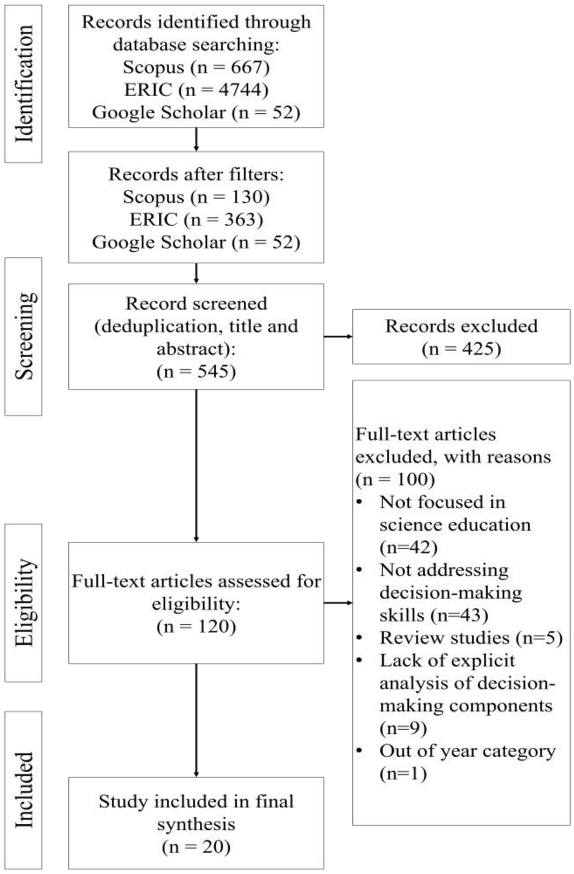

Figure 1. PRISMA flow diagram in Selection and Screening Process of Literatures

All articles from the three sources were imported into Microsoft Excel for screening. The remaining articles underwent a two-stage screening process: (1) deduplication, title and abstract screening, which reduced the number to 120 articles, (2) full-text review, based on the following criteria: (a) the study that explicitly discusses decision-making skills in science education, (b) the study addresses teaching, learning, or assessment in decision-making, (c) study involves formal education settings, (d) the primary participants are students, (e) the study is empirical study that contribute to understand the components, development, and assessment of decision-making, (f) peer-reviewed research article, (g) published between 2010-2025. After assessing for eligibility, a total of 100 articles were excluded for the following reasons: 42 articles not focused on science education, 43 articles not addressing decision-making skill, 5 articles were review studies, 9 articles lack of explicit analysis of decision-making components, and 1 article was out of year category. Therefore, a total of 20 articles were included in the final synthesis.

Data Analysis

Key themes were derived through a thematic content analysis approach by examining the articles selected. First, information of relevance was retrieved from each of the articles using a data extraction form. This was done by noting: (1) definitions of decision making, (2) elements or sub-elements of decision-making skills, (3) the context in which decision making took place (e.g., assessment, pedagogical practices, textbooks), and (4) assessment or evaluation measures used. Subsequently, the data collected were coded into themes. This was initially done using elements of decision-making skills as outlined in the literature.

On the other hand, it also enabled the identification of new themes from an inductive approach. This produced different thematic categories based on the way decisions are made in the field of science education. These patterns were examined in relation to the research questions and gaps in previous literature.

RESULTS AND DISCUSSION

The total number of studies that have been analyzed from 2010 to 2025 is 20 studies. The main findings from the analysis include: (1) conceptual framework on decision-making components; (2) type of decision criteria students generated in order to make a decision; and (3) description of instructional procedures and materials that have been used to facilitate decision-making activities in science classes.

Synthesized Components of Decision-Making Skill

The findings were analyzed using a systematic process of extraction, coding, and classification of patterns to generate an overall conceptual framework. However, the number of decision-making elements in the studies varied from one another. While some studies shared similar components, others introduced unique or additional ones.

The process of extraction, coding, and categorization resulted in eight key components of decision-making skills: (1) Identifying problems involves defining the issue clearly to frame and guide reasoning, (2) Collecting scientific data and evidence refers to gathering relevant scientific information to support the decision-making, (3) Considering multiple perspectives entails examining various viewpoints related to the issue (4) Generating options focuses on proposing a range of possible solutions or alternatives, (5) Developing criteria establishes standards for comparing those options fairly, (6) Assessing pros and cons is to weigh benefits and drawbacks logically, (7) Selecting and justifying decisions means making a choice and supporting it with evidence and reasoning, and (8) Evaluating decisions involves reflecting on and assessing the outcomes of the chosen decision. The overview is presented in Table 1.

Table 1. Overview of operational definition applied across studies

Articles	Identify Problem	Collect Scientific Data and Evidence	Consider Multiple Perspectives	Generate Options	Develop Criteria	Assess Pros and Cons	Select and Justify Decisions	Evaluate Decisions
Nahum et al. (2010)	✓	✓	-	✓	✓	✓	✓	✓
Mettas (2011)	✓	-	-	✓	✓	✓	✓	-
Liu et al. (2011)	-	✓	✓	-	✓	✓	✓	-
Papadouris (2012)	-	✓	-	✓	✓	✓	✓	-
Lee & Grace (2012)	✓	✓	✓	✓	✓	✓	✓	✓
Gresch et al. (2013)	✓	✓	✓	-	-	✓	✓	-
Sakschewski et al. (2014)	✓	-	-	✓	✓	✓	✓	✓
Gutierez (2015)	✓	-	✓	-	-	✓	✓	✓
Hsu & Lin (2017)	✓	-	-	✓	✓	✓	✓	-
Sutter et al. (2018)	✓	✓	-	✓	✓	✓	✓	✓
Lee et al. (2019)	-	-	-	✓	-	✓	✓	-
Sutter et al. (2019)	✓	✓	✓	-	✓	✓	✓	-
Mehl et al. (2020)	✓	✓	✓	-	✓	✓	✓	-
Zhang & Hsu (2021)	✓	✓	✓	-	✓	✓	✓	✓
Sakamoto et al. (2021)	✓	✓	✓	✓	✓	✓	✓	-
Luan et al. (2022)	✓	✓	-	-	-	✓	✓	-
Ben-Horin et al. (2023)	✓	✓	✓	✓	-	✓	✓	✓
Jimenez et al. (2024)	✓	✓	-	✓	-	✓	✓	✓
Dauer et al. (2025)	✓	✓	-	✓	✓	✓	✓	✓
Wahono et al. (2025)	-	-	-	✓	-	✓	✓	-
Total	16	14	9	13	13	20	20	9

The Table 1 shows that all twenty studies incorporated the components of assessing pros and cons and selecting and justifying decisions, indicating a consistent emphasis on these aspects of decision-making. Such components seem to form the basis of how decision making operates in the literature. Problem identification also seems well-represented, forming a feature of sixteen articles included in the study. However, in some cases, such components were not separately identified in the research articles (Lee et al., 2019; Liu et al., 2011; Papadouris, 2012; Wahono et al., 2025).

Moderately emphasized components include gathering scientific information and data, identifying alternatives, and establishing criteria. Even though these components appeared in 13-14 studies, they were less prominent than those which constitute the core of decision-making. In addition, it is recognized that taking multiple perspectives into account and evaluating decisions are essential characteristics of effective decision making since exposure to multiple perspectives allows students to make educated decisions while reflective evaluations enable them to assume the role of decision makers who think about possible future implications of their decisions. Nevertheless, from the review of the literature, it becomes clear that such components were rarely addressed explicitly during instruction.

Eight components that emerged as critical for analyzing decision making were considered as the main dimensions to assess the extent to which decision-making skills can be assessed within the reviewed research. Even though all reviewed articles analyzed the components of decision making, the number of components used varied widely. In other words, this study revealed that similar to the previous literature review conducted by Ratcliffe (1997), decision making had been studied differently based on various subsets of components (Grace, 2009; Ratcliffe, 1997; Sadler & Zeidler, 2005b; Yang, 2004; Zoller, 1982).

The notable finding across the reviewed studies is the consistent emphasis on two components: assessing pros and cons and selecting and justifying decisions. These appeared in all studies, reflecting their position as the most widely recognized indicators of decision-making activities. These trends are in line with the widely used definitions of decision-making as the activity of choosing the best solution from multiple alternatives (Kortland, 1996; Mettas, 2011). Such definitions naturally focus on the act of choosing, which may explain why these two components are treated as the main components of decision-making in studies. Assessing pros and cons includes activities such as developing pro and con arguments for each option (Sakschewski et al., 2014) , weighing each alternative based on criteria (Papadouris, 2012; Sutter et al., 2018), determining the tradeoffs of each option (Dauer et al., 2025), and comparing the pros and cons of each alternative to solve the issue (Liu et al., 2011; Nahum et al., 2010). In addition, selecting and justifying decisions involves choosing the best option (Gresch et al., 2013; Mettas, 2011; Sutter et al., 2018), making decisions and providing justifications (Lee & Grace, 2012; Zhang & Hsu, 2021) , creating a decision based on combination of options ((Bell & Lederman, 2003) , and choosing alternatives based on the analysis (Dauer et al., 2025).

Beyond those central components, a moderate number of studies also emphasized elements such as identifying the problem, collecting scientific data and evidence, generating options, and developing criteria. These components, although not applied in all literature, play essential roles in enabling students to weigh alternatives effectively and justify their decisions. The findings show that some studies highlighted these components explicitly, while in others they were embedded implicitly, for example, generating options was occasionally excluded because alternatives were provided by the researcher (Liu et al., 2011; Mehl et al., 2020; Sutter et al., 2019; Zhang & Hsu, 2021), and developing criteria was integrated into the activity of evaluating pros and cons (Ben-Horin et al., 2023; Gresch et al., 2013; Gutierez, 2015; Jimenez et al., 2024). The literature affirms the importance of these components. Prior studies indicate that students are more likely to reach rational and evidence-based decisions when they engage in problem identification, systematic information gathering, option generation, and the construction of decision criteria (Nahum et al, 2010; Sutter et al., 2018). The ability to filter, evaluate, and select relevant information is particularly crucial in an information-rich environment, without it, decision-making may be uninformed or biased.

Two additional components, considering multiple perspectives and evaluating decisions, were emphasized in fewer studies. However, the studies that incorporated them highlight their importance for supporting higher-level reflection and fostering more sophisticated decision-making. Considering multiple perspectives encourages students to engage with diverse viewpoints. The activities includes Identify the views of potential stakeholders (Lee & Grace, 2012) , exploring favoring or opposing opinions from various stakeholders (Sakamoto et al., 2021) , and anticipating the possible views from various perspectives (Lee & Grace, 2012) , making comparisons of two-sided perspectives while choosing a position (Liu et al., 2011). In addition, evaluating decisions enables students to reflect on future consequences and to view themselves as stakeholders in the decision-making process, which enhances motivation and metacognitive engagement (Sutter et al, 2018). Although these reflective components were less frequently represented, their inclusion is central to strengthening students' ability to make well-reasoned decisions in complex science-related societal contexts.

Overall, the findings indicate that decision-making skills are operationalized through eight key components: identifying problem, collecting scientific data and evidence, considering multiple perspectives, generating options, developing criteria, assessing pros and cons, selecting and justifying decisions, and evaluating decisions. These findings informed the construction of the conceptual framework presented in Figure 2, which integrates the eight components for conceptualizing and operationalizing decision-making skills.

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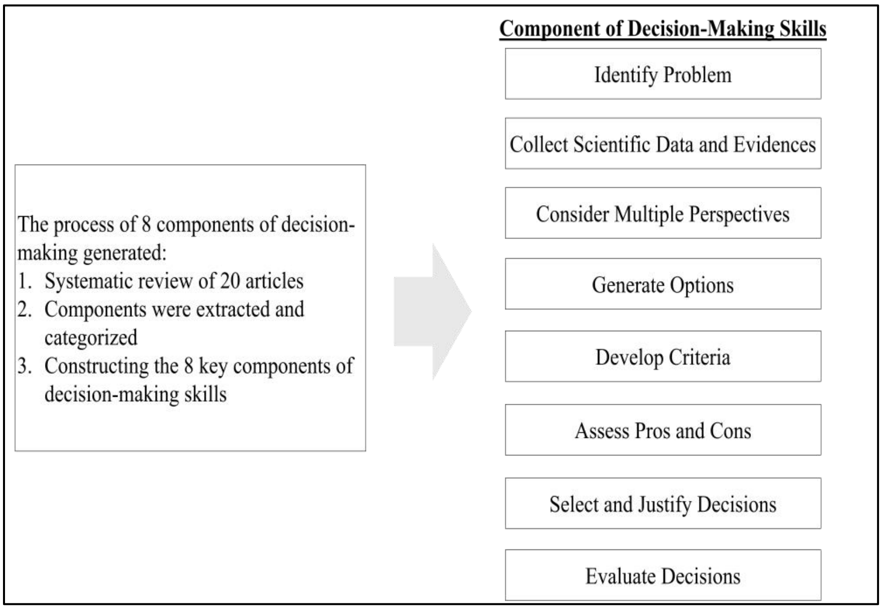

Figure 2. Conceptual Framework of Decision-Making Skills

The last conceptual framework (Figure 2) integrates the eight components mentioned above and shows their importance for competent decision-making. The presentation does not indicate that the components occur in a specific order and that each of them serves a unique purpose, including defining a problem, collecting information, considering different perspectives, generating alternative courses of action, developing selection criteria, comparing and contrasting alternatives, making a choice and defending it, and reflective judgment. This integration of all components in one model is the direct response to the deficiencies mentioned above, including insufficient consideration of such components as generative (considering perspectives) and reflective (evaluating choices). This framework can serve as the basis for the evaluation of decision-making processes and the design of instruction in future research on the subject.

Type of Criteria Used by Students in Making Decisions

This section presents an overview of the types of decision-making criteria students use, as identified in 13 out of 20 reviewed studies included developing criteria as a key component. The overview of types of criteria used is revealed in Table 2.

Table 2. Overview of the Types of Criteria Used by Students in Science Decision-Making

Articles	Scientific Evidences	Ethical Considerations	Social Considerations	Environmental Impact	Economic Feasibility	Practical Feasibility	Cultural Considerations
Nahum et al. (2010)	-	✓	✓	✓	-	✓	-
Mettas (2011)	-	-	-	-	✓	✓	-
Liu et al. (2011)	-	-	-	✓	✓	✓	-
Papadouris (2012)	-	-	-	✓	✓	✓	-
Lee & Grace (2012)	-	✓	✓	-	✓	✓	✓
Sakschewski et al. (2014)	✓	-	✓	✓	✓	✓	-
Hsu & Lin (2017)	-	✓	✓	✓	-	✓	-
Sutter et al. (2018)	-	✓	✓	✓	✓	✓	-
Sutter et al. (2019)	✓	✓	✓	✓	✓	✓	-
Mehl et al. (2020)	-	-	-	✓	-	-	-
Zhang & Hsu (2021)	-	-	✓	✓	✓	✓	✓
Sakamoto et al. (2021)	✓	✓	-	✓	✓	✓	-
Dauer et al. (2025)	✓	✓	✓	-	✓	✓	-
Total	3	6	7	10	9	11	2

In the process of making decisions related to socio-scientific issues in science education, students are often required to construct and apply specific criteria to guide them in assessing pros and cons of their alternatives. Based on the analysis of 13 out of 20 studies that included developing criteria as a component of decision-making, it was found that students most frequently considered four main aspects when constructing their decision criteria: practical feasibility, environmental impact, economic feasibility, social considerations, and ethical considerations. These dimensions were used when developing criteria for alternatives that related to socio-scientific issues in science education.

On the contrary, scientific evidence (3) and cultural factors (2) have not been mentioned by the participants as important criteria when developing their decision criteria. Findings reveal major categories of criteria developed by students as they engage with issues in SSI contexts while making decisions.

As seen in Table 2, criteria that are value-driven are the most common among the ones developed by students when considering alternative actions, including practicality (n=11), environmental concerns (n=10), economic viability (n=9), social issues (n=7), and ethical considerations (n=6). On the contrary, there is less evidence of students developing scientific evidence-driven criteria (n=3) and culturally driven criteria (n=2). This tendency shows a general characteristic of socioscientific decision making in which scientific evidence is hardly used in making decisions, rather there are trade-offs between society's values (Alred & Dauer, 2020; Högström et al., 2025).

From Table 2 above, we can observe that environmental and economic factors are some of the most common criteria used by the participants. This implies that the subject matters of the SSI issues could determine the evaluation criteria of students. For instance, when researching the management of exotic species, Liu et al. (2011) utilized mainly ecological and value-based criteria despite the economic, ethical, and social elements involved in the issue. However, this SSI issue was perceived as an environmental topic. On the other hand, researches on animal rights (Lee & Grace, 2012) exhibited ethical and cultural factors, whereas decision-making about genetically modified organisms (Sakamoto et al., 2021) demonstrated how the students focused on health risk, environmental, and economic factors. These examples show that SSI issues that have ethical and cultural elements elicit different types of evaluation criteria than technically framed issues.

The results from some of the selected studies also show that the students' backgrounds and experiences could have a bearing on the criteria they consider most important. This can be seen in a study conducted by Lee & Grace (2012), where, in the case of chicken slaughtering, it was shown that the students' concerns about their health, familiarity with the methods of rearing chickens, and sociocultural behaviors affected the criteria they considered relevant. Those who were familiar with the poultry industry tended to focus on the economic factors, while those familiar with cultural practices of food considered sociocultural criteria.

An additional interpretive variable resulting from the analysis of studies is connected to the variety of information used in the learning process. The research that employed the use of diverse forms of information, including opinions of stakeholders, contradictory information, and information of experts, presented a wider variety of criteria (Practical Feasibility, Environmental Impact) as well (Table 2) (Lee & Grace, 2012). On the other hand, less information indicates fewer criteria as well. Therefore, one can assume that the decision-making of students in the SSI framework is related to the variety of information used by them.

Synthesizing patterns observed in Table 2 frequencies alongside qualitative descriptions from the included studies suggests three interpretive factors that may help explain variations in students' criteria development: (1) the nature and framing of SSI topics, (2) the range of perspectives and information sources provided, and (3) students' prior experiences and sociocultural backgrounds. Although 13 of the 20 studies emphasized the importance of criteria development, the findings indicate that students do not automatically generate diverse or balanced criteria without instructional support.

Instructional Practices and Teaching Materials for Supporting Decision-Making Skills

Table 3 highlights the instructional activities and learning resources employed in the classroom interventions on decision making as reported in seventeen of the studies analyzed. It is observed from the results that discussion and group work activities have been applied the most, with their presence in thirteen out of the seventeen studies. Such activities have been integrated with various other activities such as case studies, oral presentations, role playing, debate, simulation, and design. Similarly, the teaching materials used across studies included worksheets, modules, computer-based programs, and multimedia resources such as videos and slides. Instructional practices and teaching materials used across the reviewed studies are presented in Table 3.

Table 3. Instructional Practices and Teaching Materials Used Across Reviewed Studies

Articles	Instructional Practices	Teaching Materials
Nahum et al. (2010)	Discussion, group work, case study, roleplay	Scenario-based worksheet, module
Mettas (2011)	Discussion, group work	Design project instruction
Papadouris (2012)	Discussion, group work, oral presentation	Module
Lee & Grace (2012)	Discussion, group work, oral presentation	Scenario-based worksheet
Gresch et al. (2013)	Case study, web-based training	Scenario-based worksheet
Sakschewski et al. (2014)	Case study	Scenario-based worksheet
Gutierez (2015)	Case study, debates, roleplay	Scenario-based worksheet
Hsu & Lin (2017)	Discussion, group work, simulation	Scenario-based worksheet, module
Sutter et al. (2018)	Discussion, group work, case study	Scenario-based worksheet, module
Lee et al. (2019)	Discussion, group work, oral presentation	Videos, slides
Sutter et al. (2019)	Discussion, group work, case study	Scenario-based worksheet, module
Mehl et al. (2020)	Case study	Computer-based program
Zhang & Hsu (2021)	Discussion, group work	Scenario-based worksheet, module
Sakamoto et al. (2021)	Discussion, consensus building activity	Scenario-based learning materials
Ben-Horin et al. (2023)	Discussion, group work	Computer-based program
Jimenez et al. (2024)	Discussion, group work, case study	Scenario-based worksheet, module
Wahono et al. (2025)	Discussion, group work, case study	Scenario-based worksheet, module, design project

Across the reviewed studies, substantial variation was observed in both the instructional practices implemented and the teaching materials provided to students. Rather than relying on a single pedagogical approach, most studies used multiple instructional practices together, suggesting that decision-making tasks were commonly delivered through integrated learning activities.

The frequencies of these practices and materials have been reported in Table 4 and Table 5. As can be observed, while some of the instruction practices were frequently used in studies, especially discussion and collaboration-based formats, others like debate, simulations, and design were used less often. Similarly, while worksheets and modules were used quite often as the material for engagement, digital media were not used often in the existing studies. It can thus be said that these tables provide a summary of the use of various types of instructions and materials to engage students in making decisions in the science classroom. Furthermore, as discussed in detail before, these findings also show us which instructional practices and materials were used least often, or rather, infrequently.

Table 4. Frequency Table of Instructional Practices

Instructional Practices	Frequency
Discussion	13
Group work	12
Case study	9
Oral presentation	3
Roleplay	2
Simulation	1
Debate	1
Consensus building activity	1
Web-based training	1

Table 5. Frequency Table of Teaching Materials

Teaching Materials	Frequency
Worksheet (Scenario-based Task)	11
Modules	8
Computer-based program	2
Design project	2
Videos	1
Slides	1

Across the 17 studies that reported instructional design, SSI-based decision-making activities were implemented using diverse combinations of instructional practices and learning materials. The most common patterns involved discussion, group work, and scenario-based worksheets, which appeared together across multiple papers. These combinations indicate that SSI decision-making was typically framed as a collaborative and scaffolded process. This finding is aligned with the fact that group discussion mostly stands out as the dominant instructional practice used (Högström et al., 2025).

In contrast, less frequently used practices, such as simulations, roleplay, debate, or digital training platforms, appeared in only a small number of studies. Importantly, their low frequency does not indicate inadequacy, rather, it reflects differences in research aims and methodological constraints. However, roleplay and debate are closely related to group discussion in that these instructional methods require students to communicate and reason collaboratively, although they differ in how the activities are structured.

Gresch et al. (2013) adopted a computer-based training program specifically to enhance students' decision-making competence, while Gutierez (2015) integrated debate and roleplay to promote bioethical reasoning, and Hsu & Lin (2017) incorporated simulation and metacognitive prompts to support a structured decision-making process.

These examples show that although used infrequently, immersive or technology-supported designs offer additional, underexplored opportunities for eliciting higher-level decision-making processes, such as enhancing the ability to justify decisions through debate, engaging with stakeholder perspectives within roleplay, and coordinating multiple sources of information. Nevertheless, the implementation of these methods can be challenging for teachers, which may limit their use in classroom practice (Högström et al., 2025).

Scenario-based worksheets and structured modules served as the dominant scaffolding tools, guiding students through problem identification, evidence evaluation, and comparison of alternatives. This reflects a trend toward structured support, which can help students navigate complex SSI tasks in their decision-making process (Dauer et al., 2022; Garrecht et al., 2020).

All together, all these features indicate that the currently existing instruction designs on the subject under analysis have a tendency to use collaborative communication between the students and also to provide some structures for working out problems, thus successfully fostering some of the most important aspects of decision making. However, the variability of methods used in various papers also indicates that there is much space left for developing instructional means to foster other elements of decision-making too.

Limitations of the Study

The limitations of this systematic review are inherent to the search strategy and the specific inclusion and exclusion criteria employed, which collectively defined the breadth and depth of the analysis (Gough et al., 2019). First, this review was limited to empirical studies published between 2010 and 2025. While this timeframe was selected to capture the most recent development in decision making, it inevitably excludes foundational studies prior to 2010 (e.g., Lee, 2007) that may still influence current theoretical perspectives.

Second, the analysis of instructional practices and teaching materials was limited by the level of detail provided in the original articles. Many reviewed studies focused primarily on student outcomes without providing comprehensive descriptions of instructional materials used. As a result, this review reports on the trends of material types, but cannot fully evaluate the specific design features or quality of these materials.

CONCLUSION

The present study conducted a systematic review of empirical literature published from 2010 to 2025 to operationalize the concept of decision-making in science education. It was observed that decision-making is not a one-off act but rather a multifaceted process that consists of eight critical steps, including recognizing the problem, gathering scientific data and information, examining various viewpoints, creating options, forming criteria, comparing the benefits and disadvantages, deciding and defending the choice, and evaluating the choice. In addition, this theoretical model provides an exhaustive map for overcoming the deficiencies associated with earlier models. This study also highlighted that students had the capability to create several criteria for decision-making. Students exhibited a marked preference for value-based evaluation, emphasizing practicality, economics, environment, and ethics while underutilizing scientific information and cultural considerations. Finally, in terms of instructional support, the prevalent mode remains conventional tools like worksheets and classroom discussions, which indicates the limited usage of other modes of active learning, such as debates and simulations.

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