



Teaching Natural Science Topics Linked to Socio-Ecological Issues to Develop Lower Secondary Students' Decision-Making Competence: A Survey of Teachers

Kieu Thi Khanh¹, Do Huong Tra², Nguyen Quang Linh^{3*}

¹Thai Nguyen University of Technology, Thai Nguyen University, Thai Nguyen, Vietnam

²Hanoi National University of Education, Hanoi, Vietnam. ORCID: <https://orcid.org/0000-0002-0083-9311>

³Thai Nguyen University of Education, Thai Nguyen, Vietnam. ORCID: <https://orcid.org/0000-0003-3369-358X>

ABSTRACT: This study examined lower secondary Natural Science (NS) teachers' perceptions, levels of implementation and difficulties in teaching NS topics linked to local socio-ecological issues to develop students' decision-making competence. Data were collected from 54 NS teachers in Thai Nguyen city using a five-point Likert questionnaire and analysed with JASP. Reliability coefficients ranged from 0.734 to 0.828 (Cronbach's α) and from 0.752 to 0.829 (McDonald's ω). Teachers agreed with the role of decision-making competence and the suitability of local socio-ecological issues as teaching contexts ($M = 3.99$), whereas the related teaching activities were implemented occasionally ($M = 2.72$). Using assessment tools for students' decision-making processes received the lowest score ($M = 2.61$). Teachers rated the difficulties at the "difficult" level ($M = 3.99$), with the lack of local teaching materials and situations reported most frequently (79.6%); 90.7% of the teachers had not attended related professional development. The findings provide a basis for developing locally contextualised materials, assessment tools for decision-making competence and professional development content for teachers.

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Nguyen Quang Linh

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1. INTRODUCTION

The 2018 General Education Curriculum in Vietnam sets the goal of forming and developing students' qualities and competencies. At the lower secondary level, Natural Science (NS) is designed as an integrated subject covering physics, chemistry, biology and Earth science, with the aim of developing NS competence in three components: NS cognition, inquiry into nature, and application of acquired knowledge and skills. Within the component of inquiry into nature, the curriculum specifies the indicator "making decisions and proposing opinions" on the issues investigated (MOET, 2018). Decision-making competence is therefore a requirement stated in the curriculum, and it needs to be translated into concrete teaching and assessment activities.

In international science education, decision-making on socioscientific issues (SSI) is regarded as a component of scientific literacy for citizenship. These issues contain scientific content and are also linked to the economic, social, environmental and ethical interests of communities (Zeidler et al., 2005). Ratcliffe (1997) described students' decision-making on such issues as identifying options, selecting criteria, using scientific information to evaluate the options and choosing among them. Garrecht et al. (2020) reported that the phase of selecting an option requires explicit instructional guidance.

Recent reviews indicate that SSI-based teaching has been widely studied, whereas its uptake in school practice remains limited. Viehmann et al. (2024) analysed 106 articles published between 2013 and 2023 and identified obstacles including resistance to pedagogical innovation, the complexity of the topics and the need for teacher training. Höglström et al. (2024) synthesised 157 studies and concluded that SSI teaching has not been widely implemented in schools despite being recommended. Upper secondary

students are the group most frequently addressed in SSI research in K-12 education (Ban & Mahmud, 2024). From the teachers' perspective, Chen and Xiao (2021) reviewed 25 empirical studies and showed that teachers often hold a partial understanding of SSI-based teaching and face challenges at the teacher, student and policy levels.

In Vietnam, studies on teaching linked to social and environmental contexts have proposed teaching processes based on the STSE model (D. L. Nguyen et al., 2023), the STEM model linked to social contexts (STEMS) (Q. L. Nguyen & Tran, 2023; Do et al., 2025) and problem-based learning in STEM lessons in NS (Han & Do, 2023). These studies mainly designed teaching processes and illustrated them with a specific topic. Surveys of NS teachers have addressed integrated teaching in general (T. H. Nguyen & Do, 2024) or the integration of education for sustainable development into physics content (Le & Truong, 2025). Published data on teachers' perceptions, levels of implementation and difficulties when teaching NS topics linked to local socio-ecological issues with the aim of developing lower secondary students' decision-making competence remain limited.

Situations such as mineral mining, production in craft villages, waste treatment and the use of fertilisers and pesticides can serve as contexts in which students apply NS knowledge to examine options for their communities. Turning these situations into learning activities depends on teachers' perceptions, experience and working conditions; therefore, examining the current situation from the teachers' perspective is a necessary step before designing teaching topics and assessment tools.

This study surveyed lower secondary NS teachers to answer three research questions: (1) How do teachers perceive decision-making competence and teaching linked to socio-ecological issues? (2) To what extent do teachers implement teaching activities aimed at developing decision-making competence? (3) What difficulties do teachers encounter when organising teaching on these topics?

2. THEORETICAL BACKGROUND

2.1. *Decision-making competence in science teaching*

In science education, decision-making is understood as the process of choosing a course of action from possible options on the basis of relevant criteria and information. For socioscientific issues, this process goes beyond finding a scientifically correct answer and requires learners to consider the values, interests and consequences of each option for the stakeholders involved (Ratcliffe, 1997; Zeidler et al., 2005). Ratcliffe (1997) proposed a decision-making framework consisting of identifying options, selecting criteria, clarifying information, evaluating the advantages and disadvantages of each option against the criteria, choosing an option and reviewing the process.

The model of decision-making competence developed by researchers at the University of Göttingen approaches this competence from decision theory and education for sustainable development. Within this line of research, the ability to compare options using decision-making strategies is a component of interest. Eggert and Bögeholz (2010) distinguished compensatory strategies, in which a weakness of an option on one criterion can be offset by a strength on another, from non-compensatory strategies, in which an option is rejected if it fails to meet a given criterion; students' responses regarding the use of these strategies were modelled with the Rasch partial credit model. Garrecht et al. (2020) treated socioscientific decision-making as a multi-phase process and distinguished the pre-selectional phase (constructing a decision space with options, criteria and information) from the selectional phase.

In the 2018 NS curriculum, the indicator "making decisions and proposing opinions" belongs to the component of inquiry into nature (MOET, 2018). Based on the approaches above, this study adopts the following working definition: students' decision-making competence is the ability to identify a problem, determine criteria, collect and evaluate scientific information, compare options and make a reasoned choice regarding issues that involve scientific content and relate to the economic, social and environmental interests of the community. This definition was presented in the introduction of the questionnaire so that teachers shared the same understanding when responding.

2.2. *Socioscientific issues and local socio-ecological issues in Natural Science teaching*

Zeidler et al. (2005) proposed a theoretical framework for SSI education that differs from the Science, Technology and Society (STS) approach in its emphasis on the ethical dimension and on the development of learners' reasoning and character when engaging with contested issues. In this approach, SSI provide contexts in which students discuss, argue and make decisions. The review by Viehmann et al. (2024) showed that localised SSI constitute a frequently used group of topics, alongside environmental, genetic and health-related issues. Högstöm et al. (2024) emphasised the role of local examples in teaching complex issues because they help students relate scientific content to their living contexts.

In this study, socio-ecological issues are understood as real local situations in which human activities affect the natural environment and are simultaneously linked to the livelihoods, health and interests of the community, such as mineral mining, production in craft villages, waste treatment and the use of fertilisers and pesticides. These situations share the characteristics of SSI: they contain scientific content (physical, chemical and biological processes), involve multiple stakeholders with different interests and allow several possible solutions.

In Vietnam, several studies have brought social and environmental contexts into science teaching. D. L. Nguyen et al. (2023) proposed a teaching process based on the STSE model for the topic “Renewable energy” to foster grade 10 students’ competence in solving problems of sustainable development. Do et al. (2025) developed a teaching process based on the STEMS model and illustrated it with the topic “Indigo dyeing” (Physics 11), linking physics content with local culture and environment. These studies have not focused on the decision-making competence of lower secondary students.

2.3. Teachers in teaching linked to socioscientific issues

Teachers select situations, organise activities and assess students; consequently, their perceptions and working conditions influence the implementation of SSI-based teaching. Lee et al. (2006) investigated Korean secondary science teachers’ perceptions of introducing SSI into the science curriculum, examining factors such as perceived necessity of SSI, personal science teaching efficacy beliefs regarding SSI and situational factors. El Arbid and Tairab (2020) surveyed 130 science teachers in the United Arab Emirates and found positive views on including SSI in the curriculum, with resources, teaching strategies and knowledge identified as facilitating factors. Chen and Xiao (2021) classified the challenges into three levels (teacher, student and policy) and argued that SSI-based teaching should be supported collaboratively rather than relying on individual teachers.

In the Vietnamese context, NS is a new lower secondary subject under the 2018 curriculum, while many in-service teachers were trained in a single science discipline. V. H. Nguyen et al. (2020) described the Vietnamese education system and science teacher training. T. H. Nguyen and Do (2024) surveyed 160 NS teachers trained in physics, chemistry or biology on their awareness and organisation of integrated teaching as a basis for proposing solutions in NS teacher education. Le and Truong (2025) reported that teachers and students held positive perceptions of education for sustainable development, but implementation was constrained by a lack of teaching materials, limited professional development opportunities and time pressure. Regarding learning materials, Pham et al. (2025) identified inconsistencies in the presentation of several concepts across grade 9 NS textbook series, which may cause difficulties for teachers and students. Q. L. Nguyen et al. (2023) identified the competencies that teachers need to develop in order to implement STEM-oriented teaching in Thai Nguyen province.

2.4. Analytical framework

Based on the analysis above, the study developed an analytical framework with three groups of indicators. The first group concerns teachers’ perceptions of the role of decision-making competence, the suitability of local socio-ecological issues as teaching contexts, the need to coordinate multiple criteria in decision-making, the conditions provided by the curriculum and the capability of lower secondary students. The second group concerns the implementation of teaching activities corresponding to the phases of decision-making: using local situations as starting points, guiding students in setting criteria and evaluating information, organising the comparison of options and argumentation, and using tools to assess the decision-making process. The third group concerns difficulties related to teaching materials and situations, to time allocation and assessment requirements, and to assessment tools and criteria. These three groups correspond to the three research questions.

3. METHOD

The study employed a quantitative cross-sectional survey design. Participants were 54 teachers teaching NS at lower secondary schools in Thai Nguyen city. Convenience sampling was used: an online questionnaire was created in Google Forms and distributed to teachers from 20 September 2026 to 1 October 2026. To ensure anonymity, the questionnaire did not collect information on respondents’ schools. All 54 returned questionnaires were complete and included in the analysis. Before analysis, the data were checked for missing values and out-of-range codes; no cases needed to be excluded.

The questionnaire comprised an introduction and two content sections. The introduction presented the purpose of the study, the working definition of decision-making competence, examples of local socio-ecological issues and a confidentiality statement. Section A collected background information on gender, highest qualification, undergraduate major, teaching experience and participation in professional development on environmental education, education for sustainable development or context-based teaching. Section B consisted of 12 items in three groups. Group B1 (5 items) measured perceptions on an agreement scale from 1 (strongly disagree) to 5 (strongly agree). Group B2 (4 items) measured implementation on a frequency scale from 1 (never) to 5 (very often). Group B3 (3 items) measured difficulty on a scale from 1 (not difficult) to 5 (very difficult). The items were developed by the research team on the basis of the literature review and the analytical framework in Section 2.4; the questionnaire was not validated through expert review.

Participation was voluntary. Teachers confirmed their consent before responding and could withdraw at any time. The questionnaire did not collect names, telephone numbers, school names or other identifying information; the data were stored in a password-protected file and used for research purposes only.

The data were coded and analysed with JASP version 0.96 (Apple silicon). Background information was described using frequencies and percentages. For each Section B item, the percentage of responses at each level, the mean (M) and the standard deviation (SD) were calculated; the overall score of each group was the mean of its items. The internal consistency of the three scales was estimated with Cronbach’s α and McDonald’s ω with 95% confidence intervals; ω was reported in addition because it

does not assume equal factor loadings across items (Hayes & Coutts, 2020). Alpha-if-item-deleted values were used to examine the contribution of each item to its scale. Mean scores were interpreted using five intervals of width $(5 - 1)/5 = 0.8$: 1.00–1.80, 1.81–2.60, 2.61–3.40, 3.41–4.20 and 4.21–5.00, corresponding to the five levels of each scale.

4. RESULTS

4.1. Participant characteristics

Table 1 presents the characteristics of the 54 participating teachers. Female teachers accounted for 74.1%. Most teachers held a bachelor's degree (85.2%) and had more than 5 to 20 years of teaching experience (59.3%). Regarding their majors, 85.2% were trained in a single science discipline (physics education 35.2%, biology education 25.9%, chemistry education 24.1%), and 14.8% were trained in NS education. Forty-nine teachers (90.7%) had not attended professional development on environmental education, education for sustainable development or context-based teaching; five teachers (9.3%) had attended one course.

Table 1. Characteristics of participating teachers (N = 54)

Characteristic	Category	n	%
Gender	Male	14	25.9
	Female	40	74.1
Highest qualification	Bachelor	46	85.2
	Master	8	14.8
Undergraduate major	Physics education	19	35.2
	Chemistry education	13	24.1
	Biology education	14	25.9
	Natural Science education	8	14.8
Teaching experience	Less than 5 years	6	11.1
	More than 5 to 20 years	32	59.3
	More than 20 years	16	29.6
Professional development on EE, ESD or context-based teaching	None	49	90.7
	One course	5	9.3

Note. EE = environmental education; ESD = education for sustainable development. No teacher held a college diploma and no teacher had attended two or more courses.

4.2. Reliability of the scales

The reliability coefficients of the three scales were as follows: B1, $\alpha = 0.770$ [95% CI: 0.638, 0.902] and $\omega = 0.772$ [0.676, 0.868]; B2, $\alpha = 0.734$ [0.607, 0.861] and $\omega = 0.752$ [0.645, 0.858]; B3, $\alpha = 0.828$ [0.676, 0.980] and $\omega = 0.829$ [0.750, 0.909]. These values are within an acceptable range for scales with few items. In group B2, the alpha-if-item-deleted value for item B2.2 (0.760) was higher than the alpha of the whole scale (0.734), indicating that this item correlated less with the other items. Item B2.2 was retained because its content reflects setting criteria and evaluating information, a component of the theoretical framework; this limitation was taken into account when interpreting the results.

4.3. Teachers' perceptions

Table 2 shows that all five B1 items had mean scores between 3.85 and 4.11, corresponding to the “agree” level; the overall score of the group was 3.99. The percentage of teachers who agreed or strongly agreed ranged from 66.7% (B1.2) to 77.8% (B1.5). Item B1.5, on lower secondary students' ability to make reasoned decisions when provided with data and criteria, received the highest score ($M = 4.11$), followed by B1.1 on the role of decision-making competence in NS ($M = 4.02$). Item B1.2, on the suitability of local socio-ecological issues as teaching contexts, received the lowest score ($M = 3.85$), with 33.3% of teachers choosing “undecided”, “disagree” or “strongly disagree”. For item B1.4, on the conditions provided by the 2018 NS curriculum, 25.9% of teachers were undecided. Item SDs ranged from 0.92 to 1.12, indicating some dispersion of opinions among teachers.

Table 2. Teachers' perceptions of decision-making competence and teaching linked to socio-ecological issues (N = 54)

Item	Statement	Percentage of responses by level (%)					M	SD	Rank
		1	2	3	4	5			
B1.1	Decision-making competence is one of the competencies that should be developed in students through NS teaching at lower secondary level	3.7	7.4	13.0	35.2	40.7	4.02	1.09	2
B1.2	Local socio-ecological issues are suitable contexts for teaching NS topics	3.7	9.3	20.4	31.5	35.2	3.85	1.12	5
B1.3	Making decisions on a socio-ecological issue requires students to combine scientific knowledge with economic, social and environmental criteria	3.7	5.6	20.4	29.6	40.7	3.98	1.09	3
B1.4	The 2018 NS curriculum enables teachers to organise teaching linked to local socio-ecological issues	1.9	1.9	25.9	37.0	33.3	3.98	0.92	3
B1.5	Lower secondary students can make reasoned decisions when provided with appropriate data and evaluation criteria	3.7	3.7	14.8	33.3	44.4	4.11	1.04	1

Note. 1 = strongly disagree; 2 = disagree; 3 = undecided; 4 = agree; 5 = strongly agree. Cronbach's $\alpha = 0.770$; McDonald's $\omega = 0.772$.

4.4. Implementation of teaching activities

Table 3 shows that all four activities had mean scores between 2.61 and 2.93, corresponding to the “occasionally” level; the overall score of the group was 2.72. The percentage of teachers implementing the activities often or very often ranged from 13.0% (B2.4) to 29.6% (B2.1). Using real local socio-ecological situations as starting points for lessons (B2.1) received the highest score (M = 2.93). The two activities directly linked to components of decision-making, namely guiding students to set criteria and evaluate the reliability of information (B2.2) and organising students to compare options and present arguments (B2.3), both had M = 2.67; 51.9% and 44.4% of teachers, respectively, never or rarely implemented them. Using assessment tools such as rubrics, checklists and observation sheets to assess the decision-making process (B2.4) received the lowest score (M = 2.61), with 40.7% of teachers never or rarely doing so.

Table 3. Implementation of teaching activities aimed at developing decision-making competence (N = 54)

Item	Statement	Percentage of responses by level (%)					M	SD	Rank
		1	2	3	4	5			
B2.1	Using real local socio-ecological situations as starting points for NS lessons	11.1	18.5	40.7	25.9	3.7	2.93	1.03	1
B2.2	Guiding students to set selection criteria and evaluate the reliability of information before making decisions	5.6	46.3	25.9	20.4	1.9	2.67	0.93	2
B2.3	Organising students to compare possible solutions and present arguments for their choices	5.6	38.9	38.9	16.7	0.0	2.67	0.82	2
B2.4	Using assessment tools (rubrics, checklists, observation sheets) to assess students' decision-making processes	13.0	27.8	46.3	11.1	1.9	2.61	0.92	4

Note. 1 = never; 2 = rarely; 3 = occasionally; 4 = often; 5 = very often. Cronbach's $\alpha = 0.734$; McDonald's $\omega = 0.752$.

4.5. Difficulties in organising teaching

Table 4 shows that the three difficulties had mean scores between 3.78 and 4.15, corresponding to the “difficult” level; the overall score of the group was 3.99. The lack of teaching materials and situations linked to local socio-ecological issues (B3.1) received the highest score (M = 4.15), with 79.6% of teachers rating it as difficult or very difficult and no teacher choosing “not

difficult". The lack of tools and criteria for assessing students' decision-making competence (B3.3) ranked second ($M = 4.06$; 72.2%). Limited instructional time and the requirement to complete assessment content (B3.2) received a lower score ($M = 3.78$; 64.8%).

Table 4. Teachers' difficulties in teaching NS topics linked to socio-ecological issues ($N = 54$)

Item	Statement	Percentage of responses by level (%)					M	SD	Rank
		1	2	3	4	5			
B3.1	Lack of teaching materials and situations linked to local socio-ecological issues	0.0	1.9	18.5	42.6	37.0	4.15	0.79	1
B3.2	Limited instructional time and the requirement to complete assessment content	1.9	5.6	27.8	42.6	22.2	3.78	0.92	3
B3.3	Lack of tools and criteria for assessing students' decision-making competence	1.9	1.9	24.1	33.3	38.9	4.06	0.94	2

Note. 1 = not difficult; 2 = slightly difficult; 3 = moderately difficult; 4 = difficult; 5 = very difficult. Cronbach's $\alpha = 0.828$; McDonald's $\omega = 0.829$.

4.6. Summary of results

Figure 1 displays the distribution of teachers' responses across all 12 items. In the perception and difficulty groups, most responses were at levels 4 and 5; in the implementation group, most responses were at levels 2 and 3. The overall perception score ($M = 3.99$) was 1.27 points higher than the overall implementation score ($M = 2.72$) on the five-point scale. This difference is reported at the descriptive level.

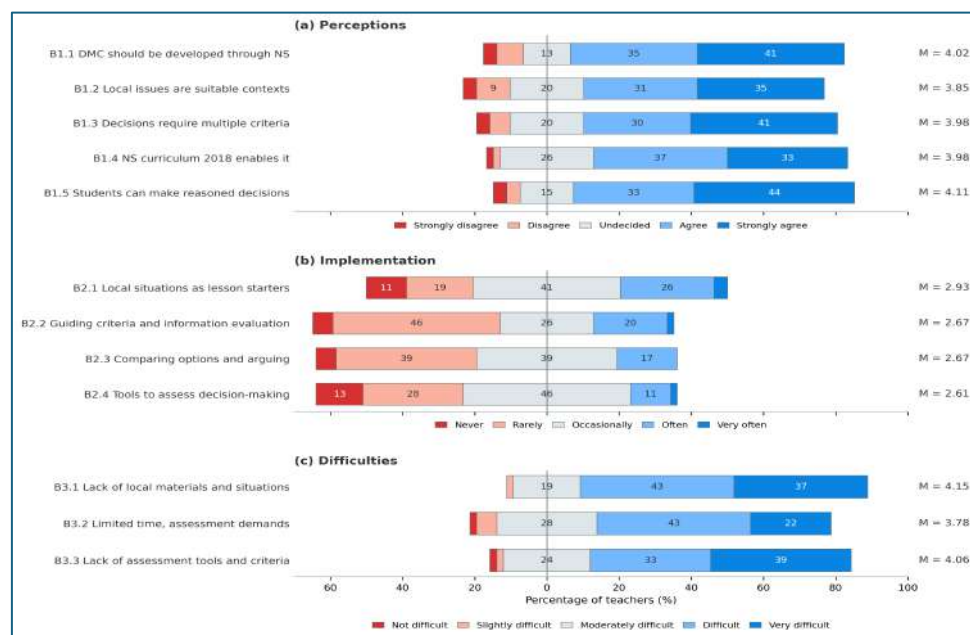


Figure 1. Distribution of teachers' responses by indicator group: (a) perceptions, (b) implementation, (c) difficulties ($N = 54$). Agreement, frequency or difficulty levels are shown to the right of zero and the opposite levels to the left; the middle level is split equally on both sides. Numbers on the bars are percentages (shown when 8% or higher).

5. DISCUSSION

The results show a gap between perception and implementation: teachers agreed with the role of decision-making competence and the suitability of local socio-ecological issues ($M = 3.99$), whereas the corresponding teaching activities were implemented occasionally ($M = 2.72$). This is consistent with the conclusion of Högström et al. (2024) that SSI teaching has not been widely implemented despite being recommended, and with studies reporting that teachers held positive views of SSI but encountered obstacles in bringing them into the classroom (Lee et al., 2006; El Arbid & Tairab, 2020; Le & Truong, 2025).

Among the activities, using local situations as lesson starters scored higher than guiding students to set criteria, evaluate information, compare options and argue. Socio-ecological situations may be used mainly to open lessons, while the decision-making

process is not yet organised into learning steps. Selecting criteria and using strategies to compare options are central components of decision-making (Ratcliffe, 1997; Eggert & Bögeholz, 2010), and the selectional phase requires explicit guidance (Garrecht et al., 2020). The finding that 51.9% of teachers never or rarely guided students in setting criteria (B2.2) reflects a gap between bringing situations into lessons and developing decision-making competence. The result for item B2.2 should be interpreted with caution because this item correlated less with the other items in its scale.

The findings on assessment were consistent across two indicator groups: using tools to assess the decision-making process had the lowest implementation score (B2.4, $M = 2.61$), and the lack of assessment tools and criteria was identified as a difficulty by 72.2% of teachers (B3.3). This corresponds to the teacher-level challenges synthesised by Chen and Xiao (2021).

The lack of teaching materials and situations linked to local socio-ecological issues was the most frequently reported difficulty (79.6%), in line with the resource-related obstacles reported by El Arbid and Tairab (2020) and Le and Truong (2025). Because local issues differ across regions, general materials can hardly meet all needs (Högström et al., 2024). The lack of materials may also be related to the 33.3% of teachers who were undecided or disagreed about the suitability of local issues as teaching contexts (B1.2). The published teaching processes based on the STSE and STEMS models (D. L. Nguyen et al., 2023; Do et al., 2025) may serve as references for building banks of local situations.

The fact that 90.7% of teachers had not attended related professional development is a factor to consider when interpreting these results. El Arbid and Tairab (2020) reported statistically significant differences in teachers' views according to the SSI-related professional development they had attended. In addition, 85.2% of the teachers in the sample were trained in a single science discipline, whereas socio-ecological issues often require coordinating knowledge from physics, chemistry and biology; this characteristic is consistent with the context described by V. H. Nguyen et al. (2020) and T. H. Nguyen and Do (2024). Because only five teachers had attended training, the two groups were not compared.

Three directions can be proposed from these results: building banks of local socio-ecological situations; developing assessment tools (rubrics) based on the components of setting criteria, evaluating information, comparing options and argumentation; and including the organisation of decision-making activities in professional development programmes for NS teachers. The study has several limitations. The sample of 54 teachers selected by convenience sampling in Thai Nguyen city limits the generalisability of the findings; because school information was not collected, differences between schools could not be examined. The questionnaire was not validated through expert review, so the content validity of the instrument requires further examination. The data were self-reported and were not triangulated with classroom observation. Future studies may expand the sample, validate the instrument and incorporate classroom observation.

6. CONCLUSION

The survey of 54 lower secondary NS teachers shows that teachers agreed with the role of decision-making competence and the suitability of local socio-ecological issues in NS teaching ($M = 3.99$). Teaching activities aimed at developing decision-making competence were implemented occasionally ($M = 2.72$), with guiding students to set criteria, comparing options and using assessment tools scoring lower than using situations to open lessons. Teachers rated the difficulties at the “difficult” level ($M = 3.99$), mainly the lack of local teaching materials and situations and the lack of assessment tools; 90.7% of the teachers had not attended related professional development. These findings provide a practical basis for designing NS teaching topics linked to local socio-ecological issues, developing assessment tools for decision-making competence and conducting teaching experiments in subsequent studies.

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