

Teaching Electric Current and Circuits Through an STSE Lens: Upper Secondary Physics Teachers' Practices, Perceptions, and Readiness in Vietnam

Nguyen Thi Thu Trang¹, Nguyen Quang Linh^{2*}, Tran Van Thanh³

¹Khuong Dinh High School, Hanoi, Vietnam

²Thai Nguyen University of Education, Thai Nguyen, Vietnam

³Hanoi National University of Education, Hanoi, Vietnam

ABSTRACT: The 2018 General Education Curriculum in Vietnam requires physics teaching to develop students' scientific competence, and the science, technology, society and environment (STSE) model has been proposed as one way to meet this requirement. Evidence on how upper secondary physics teachers currently teach specific topics in relation to STSE remains limited. This study surveyed 55 physics teachers about the topic "Electric current and circuits" (Physics 11). A 15-item questionnaire on a five-point Likert scale covered four areas: teaching practice, STSE integration, teacher-rated student scientific competence, and awareness of and readiness for the STSE model. Descriptive statistics and internal consistency coefficients (Cronbach's α and McDonald's ω) were computed. Lecturing combined with problem solving was reported by 61.8% of teachers, whereas 38.9% had implemented project-based learning for the topic, and 72.2% reported time and facility constraints. Teachers more often linked the topic to social issues (87.3%) and environmental issues (76.4%) than to modern technology (59.3%). Collecting and processing data was the lowest-rated student capability ($M = 3.18$). Although 40.7% of teachers were familiar with the STSE model, 70.4% were willing to adopt it if given materials and training. The findings indicate a gap between awareness and readiness, and point to the need for topic-specific STSE resources, professional development, and low-cost technological projects.

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Nguyen Quang Linh

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1. INTRODUCTION

The 2018 General Education Curriculum in Vietnam shifted the aim of school science from knowledge transmission toward the development of competencies, with scientific competence identified as a core outcome of physics teaching. Meeting this aim requires teaching approaches that engage students in explaining phenomena, carrying out investigations, and applying knowledge to real situations. The science, technology, society and environment (STSE) model is one approach that places scientific content within technological, social and environmental contexts (Aikenhead, 2005; Pedretti & Nazir, 2011).

In Vietnam, research on STSE has grown over the past few years. Most published studies propose teaching processes for specific topics, such as renewable energy (D. L. Nguyễn et al., 2023), energy conservation and transformation (Lê, 2025b), or power sources linked to environmental protection (Lê, 2025a). Intervention studies at the lower secondary level have reported gains in students' scientific competence and environmental science competency after STSE-based instruction (Q. L. Nguyen et al., 2025, 2026). Studies describing how teachers currently practise integrated teaching are fewer. A recent survey of 209 lower secondary science teachers found positive perceptions of STSE-based teaching but limited understanding of its instructional process (Lê et al., 2026), and a survey in Ho Chi Minh City examined the integration of education for sustainable development in upper secondary teaching (Hà & Bùi, 2024). Data on upper secondary physics teachers, and on specific physics topics, remain limited.

The topic “Electric current and circuits” in Physics 11 offers a range of connections to technology (sensors, microcontrollers, household devices), society (electrical safety, energy saving) and the environment (energy production and pollution). The topic is also known to pose conceptual difficulties for students, who often hold several misconceptions about direct current circuits even after instruction (Engelhardt & Beichner, 2004). Understanding how teachers currently teach this topic, how far they connect it to STSE contexts, how they perceive their students’ competence, and how ready they are to adopt the STSE model can inform the design of instructional materials and professional development.

This study therefore addressed four research questions:

RQ1. What teaching methods do upper secondary physics teachers report using when teaching the topic “Electric current and circuits”?

RQ2. To what extent do teachers report integrating technological, social and environmental aspects into this topic?

RQ3. How do teachers rate their students’ current scientific competence in relation to this topic?

RQ4. What are teachers’ awareness of and readiness for the STSE teaching model?

2. LITERATURE REVIEW

2.1. *The STSE model and scientific competence*

STSE education emerged from the science, technology and society movement and extends it by adding an explicit environmental dimension (Aikenhead, 2005). Pedretti and Nazir (2011) mapped the field into six currents: application and design, historical, logical reasoning, value-centred, sociocultural, and socio-ecojjustice. These currents differ in their aims, from solving practical problems through technology design to taking action on social and environmental issues. The typology suggests that “doing STSE” can range from mentioning applications of science to organising projects in which students design, test and evaluate solutions.

Empirical studies have linked STSE-based instruction with several student outcomes. Xiang and Han (2024) examined the effect of an STSE approach on high school students’ understanding of the nature of science. In Vietnam, Q. L. Nguyen et al. (2025) implemented a six-week STSE intervention on the topic “Electricity and life” with 89 eighth-grade students and reported gains in scientific competence, particularly in explaining phenomena, linking science to practice, and conducting investigations. Q. L. Nguyen et al. (2026) used a quasi-experimental design with STSE-oriented projects in the topic “Density and pressure” and reported higher environmental science competency in the experimental group than in the comparison group (partial $\eta^2 = .102$). These studies were carried out at the lower secondary level; evidence for upper secondary physics is less available.

2.2. *Teaching electric circuits and barriers to instructional change*

Research on students’ understanding of direct current circuits has documented persistent difficulties, such as treating the battery as a constant source of current and confusing current, voltage and resistance (Engelhardt & Beichner, 2004). These difficulties suggest that practising calculations alone may not be sufficient, and that hands-on investigation and contextualised tasks may support conceptual understanding.

Project-based learning (PBL) is one of the instructional forms often used to implement STSE. A meta-analysis of 30 studies involving 12,585 students found a positive overall effect of PBL on academic achievement compared with traditional instruction (Chen & Yang, 2019). The implementation of inquiry and project work, however, depends on the conditions teachers work in. Ramnarain (2014) found that physical sciences teachers held positive views of inquiry-based learning, but a lack of resources and large classes led teachers in some schools to rely on didactic teaching.

2.3. *STSE implementation and teacher readiness in Vietnam*

Vietnamese studies on STSE have mainly proposed teaching processes and illustrated them with lesson designs. D. L. Nguyễn et al. (2023) proposed an STSE-based teaching process to foster problem-solving competence for sustainable development through the topic “Renewable energy”. Lê (2025b) designed an STSE-based sequence for the topic “Energy: Conservation and transformation” (Physics 10), and Lê (2025a) proposed an integrated process linking the topic “Power sources” (Physics 11) with environmental protection education. Survey studies provide information on the conditions of implementation. Lê et al. (2026) surveyed 209 teachers in 20 lower secondary schools across five provinces and cities; teachers valued STSE-based teaching, but their understanding of the instructional process and their ability to design STSE topics were limited. The main difficulties reported were designing real-world situations, a lack of exemplary materials, unclear procedures, limited preparation time, and developing competence assessment tools. Hà and Bùi (2024) surveyed the integration of education for sustainable development in upper secondary schools in Ho Chi Minh City. To our knowledge, no published survey has focused on upper secondary physics teachers and a specific physics topic in relation to STSE, which is the focus of the present study.

3. METHOD

This study used a cross-sectional descriptive survey design. Participants were 55 upper secondary physics teachers. Data were collected using an online questionnaire (Google Forms). Participation was voluntary and anonymous, and no identifying

information was collected. Table 1 presents the characteristics of the participants. Most teachers were under 40 years old (85.5%), and the sample was distributed across years of teaching experience, with 32.7% having taught for fewer than 5 years and 40.0% for more than 10 years. Slightly more than half held a bachelor's degree (52.7%) and 43.6% held a master's degree.

Table 1. Characteristics of participants (N = 55)

Characteristic	Category	n	%
Age (years)	Under 30	21	38.2
	30 to 39	26	47.3
	40 to 49	6	10.9
	50 and over	2	3.6
Teaching experience (years)	Under 5	18	32.7
	5 to 10	15	27.3
	11 to 20	17	30.9
	Over 20	5	9.1
Qualification	Bachelor's degree	29	52.7
	Master's degree	24	43.6
	Other	2	3.6

It consisted of a demographic section (age, years of teaching, qualification) and 15 items in four sections. Section B (four items) asked about teaching practice for the topic, including the use of lecturing combined with problem solving (B1), experiments and practical work (B2), project-based learning (B3), and time and facility constraints (B4). Section C (four items) addressed the integration of technological (C1), social (C2) and environmental (C3) aspects, and the perceived difficulty of STSE integration (C4). Section D (four items) asked teachers to rate students' capabilities in explaining the practical significance of the content (D1), designing and conducting simple experiments or projects (D2), collecting and processing data (D3), and relating physics to social and environmental issues (D4). Section E (three items) addressed awareness of the STSE model (E1), willingness to adopt it with support (E2), and beliefs about its effectiveness compared with traditional methods (E3). All items used a five-point Likert scale from 1 (strongly disagree) to 5 (strongly agree). The questionnaire was administered in Vietnamese; the English wording in Tables 2 to 5 is a translation by the authors.

During data screening, 11 responses from 9 participants contained two or more selected options for a single item. Because the items required a single choice, these responses were coded as missing, and the number of valid responses per item ranged from 53 to 55. Analyses were conducted in JASP (version 0.96) with pairwise deletion. For each item, we report the number of valid responses, the mean (M), standard deviation (SD), median (Mdn) and the percentage of agreement (options 4 and 5). Following Norman (2010), means and standard deviations were used as descriptive summaries of Likert-type items, with medians reported alongside. Mean scores were interpreted using five equal bands of 0.80: 1.00 to 1.80 (strongly disagree), 1.81 to 2.60 (disagree), 2.61 to 3.40 (neutral), 3.41 to 4.20 (agree), and 4.21 to 5.00 (strongly agree).

Internal consistency was estimated for each section with Cronbach's α and McDonald's ω . Omega was reported because it does not assume equal factor loadings across items (Hayes & Coutts, 2020). A value of .70 was used as a reference point, with the caution that such thresholds are conventional and that α does not establish unidimensionality (Taber, 2018). Because α depends on the number of items, the mean inter-item correlation was also examined for the four-item Section B, with values between .15 and .50 regarded as acceptable for scales measuring a broad construct (Clark & Watson, 1995).

4. RESULTS

4.1. Internal consistency and overall response pattern

Sections C ($\alpha = .874$; $\omega = .873$), D ($\alpha = .872$; $\omega = .866$) and E ($\alpha = .793$; $\omega = .814$) showed internal consistency above the .70 reference point. For Section E, α increased to .872 when item E1 was removed, indicating that awareness of the model reflected a different aspect from willingness and beliefs; the items in Section E were therefore interpreted individually. Section B showed lower internal consistency ($\alpha = .616$; $\omega = .598$). The mean inter-item correlation of Section B was .29, within the range suggested by Clark and Watson (1995), and item-rest correlations ranged from .23 (B1) to .54 (B4). Reverse-coding B1 and B4 reduced α to .14, because B1 and B4 were positively correlated ($\rho = .39$). Items B2 and B3, which describe active teaching practices, showed $\alpha = .70$ ($\rho = .47$). Section B was therefore treated as a set of related indicators of teaching practice and was not summarised as a single score. Figure 1 presents the distribution of responses for all 15 items.

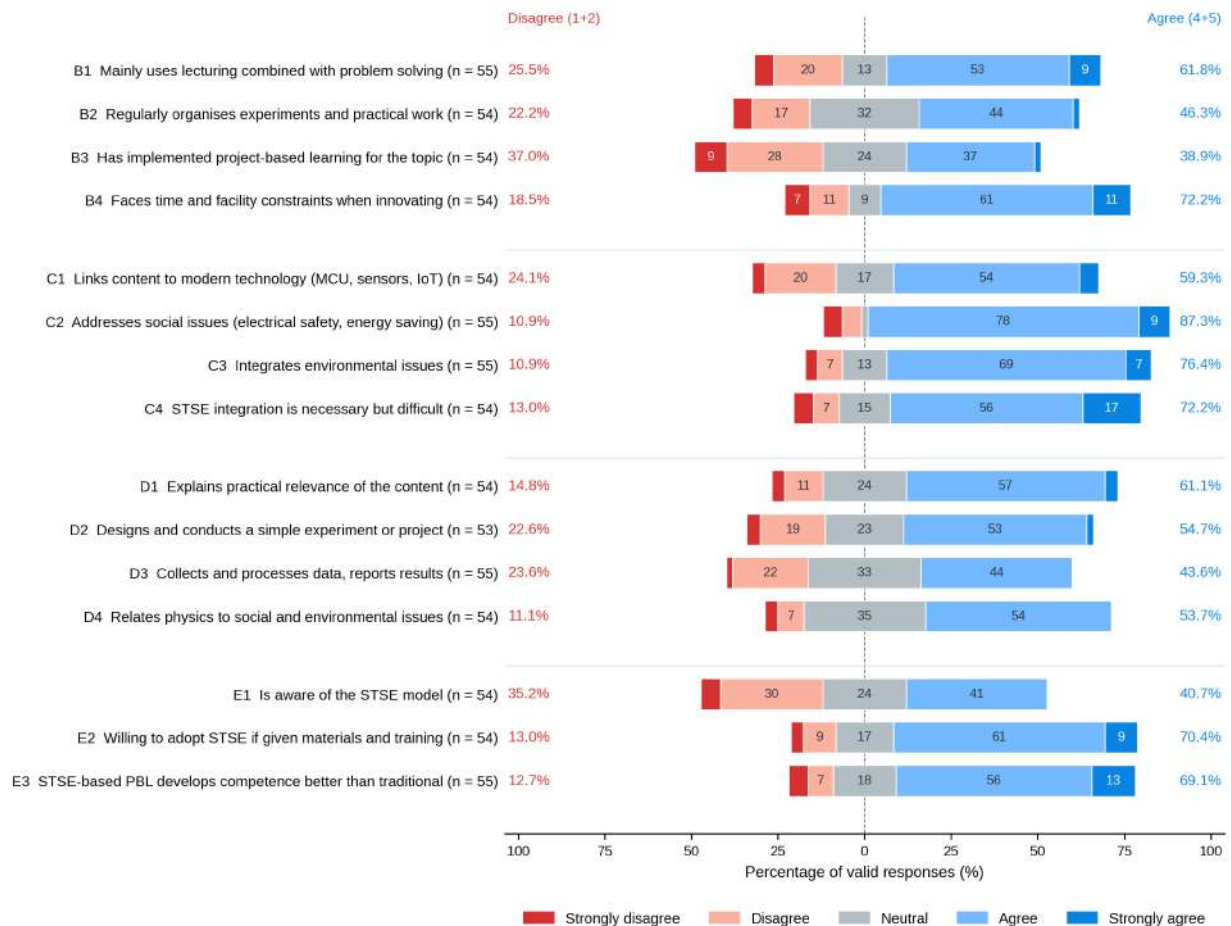


Figure 1. Distribution of teachers' responses to the 15 Likert-type items (percentage of valid responses). Bars are centred on the neutral category; values on the left and right show the combined percentages of disagreement (1 + 2) and agreement (4 + 5). B = teaching practice; C = STSE integration; D = teacher-rated student scientific competence; E = awareness and readiness.

4.2. Teaching practice (RQ1)

As shown in Table 2, 61.8% of teachers agreed that they mainly used lecturing combined with problem solving when teaching the topic ($M = 3.40$). Fewer than half (46.3%) regularly organised experiments and practical work, and 31.5% selected the neutral option for this item ($M = 3.20$). Item B3 had the lowest mean of all 15 items ($M = 2.94$): 38.9% of teachers had implemented project-based learning for the topic, while 37.0% had not. Item B4 had the highest mean in Section B ($M = 3.57$), with 72.2% of teachers reporting time and facility constraints when trying to innovate their teaching.

Table 2. Teachers' reported teaching practice for the topic "Electric current and circuits"

Item	Statement	n	M	SD	Mdn	Agree (%)	α if deleted
B1	I mainly use lecturing combined with problem-solving exercises when teaching the topic.	55	3.40	1.08	4	61.8	.666
B2	I regularly organise experiments and practical work for students when teaching this topic.	54	3.20	0.94	3	46.3	.522
B3	I have implemented project-based learning for the topic "Electric current and circuits".	54	2.94	1.05	3	38.9	.544
B4	I face difficulties with time and facilities when trying to innovate teaching methods for this topic.	54	3.57	1.08	4	72.2	.426

Note. Agree = percentage of options 4 and 5 among valid responses; α if deleted = Cronbach's α of the section when the item is removed. Section B: $\alpha = .616$; $\omega = .598$ (95% CI [.425, .772]). Full response distributions are shown in Figure 1.

4.3. Integration of technological, social and environmental aspects (RQ2)

Table 3 shows that social issues were the aspect most often integrated: 87.3% of teachers agreed that they regularly addressed issues such as electrical safety and energy saving ($M = 3.80$). Environmental issues were integrated by 76.4% ($M = 3.69$). Links to

modern technology such as microcontrollers, sensors and the Internet of Things had a lower agreement rate (59.3%; $M = 3.37$), and 24.1% of teachers disagreed with this item. At the same time, 72.2% of teachers considered STSE integration necessary but difficult to implement ($M = 3.70$).

Table 3. Integration of technological, social and environmental aspects

Item	Statement	n	M	SD	Mdn	Agree (%)	α if deleted
C1	I regularly relate the topic to modern technological applications (microcontrollers, sensors, IoT).	54	3.37	1.00	4	59.3	.850
C2	I regularly address social issues (electrical safety, energy saving, community health) when teaching this topic.	55	3.80	0.89	4	87.3	.796
C3	I regularly integrate environmental issues (air pollution, sustainable development) into lessons on this topic.	55	3.69	0.86	4	76.4	.841
C4	Integrating science, technology, society and environment into teaching is necessary but difficult to implement in practice.	54	3.70	1.02	4	72.2	.869

Note. Abbreviations as in Table 2. Section C: $\alpha = .874$; $\omega = .873$ (95% CI [.818, .928]).

4.4. Teacher-rated student scientific competence (RQ3)

Teachers rated students' ability to explain the practical significance of the content highest in Section D ($M = 3.46$; 61.1% agreement) (Table 4). The ability to design and conduct a simple experiment or project received 54.7% agreement ($M = 3.30$). The ability to collect and process data and present results received the lowest rating ($M = 3.18$), with 43.6% agreement, 32.7% neutral responses, and no responses at the strongly agree level. Students' awareness of relating physics to social and environmental issues received 53.7% agreement and 35.2% neutral responses ($M = 3.39$). Three of the four items had means in the neutral band.

Table 4

Teachers' ratings of students' current scientific competence

Item	Statement	n	M	SD	Mdn	Agree (%)	α if deleted
D1	Students can explain the practical significance of knowledge about electric current and circuits in daily life.	54	3.46	0.88	4	61.1	.855
D2	Students can design and carry out a simple experiment or project related to electric circuits.	53	3.30	0.93	4	54.7	.825
D3	Students can collect and process data and present research results scientifically.	55	3.18	0.84	3	43.6	.821
D4	Students relate physics knowledge to social and environmental issues during learning.	54	3.39	0.79	4	53.7	.841

Note. Abbreviations as in Table 2. Section D: $\alpha = .872$; $\omega = .866$ (95% CI [.808, .924]).

4.5. Awareness of and readiness for the STSE model (RQ4)

As shown in Table 5, 40.7% of teachers reported being familiar with the STSE model, 35.2% were not, and 24.1% were neutral ($M = 3.00$). In contrast, 70.4% were willing to adopt the model if provided with guidance materials and training ($M = 3.63$), and 69.1% believed that STSE-based project learning could develop students' scientific competence better than traditional methods ($M = 3.64$).

Table 5. Teachers' awareness of and readiness for the STSE model

Item	Statement	n	M	SD	Mdn	Agree (%)	α if deleted
E1	I am familiar with the STSE teaching model.	54	3.00	0.97	3	40.7	.872
E2	I am willing to apply the STSE model if provided with guidance materials and training.	54	3.63	0.92	4	70.4	.584
E3	Project-based learning following the STSE model can develop students' scientific competence better than traditional methods.	55	3.64	0.99	4	69.1	.669

Note. Abbreviations as in Table 2. Section E: $\alpha = .793$; $\omega = .814$ (95% CI [.731, .896]).

5. DISCUSSION

This study examined upper secondary physics teachers' practices, STSE integration, ratings of students' competence, and readiness for the STSE model in relation to the topic "Electric current and circuits". Four patterns emerged from the data.

First, lecturing combined with problem solving was reported as the main method by about three in five teachers, while fewer than half regularly organised experiments and fewer than two in five had implemented project-based learning for the topic. Most teachers reported time and facility constraints. This pattern is consistent with Lê et al. (2026), where limited preparation time and a lack of exemplary materials were among the main difficulties in implementing STSE at the lower secondary level, and with Ramnarain (2014), who found that resource constraints led teachers to rely on didactic teaching even when they valued inquiry. The internal structure of Section B provides additional information. Items B1 and B4 were positively correlated, so that teachers who reported relying on lecturing also tended to report constraints. Reverse-coding these two items did not produce a coherent scale, which suggests that teachers did not perceive lecturing and active methods as two ends of one continuum. Rather, lecturing and constraints appeared to co-occur, while experiments and project work formed a second cluster. This interpretation is exploratory given the small number of items and the modest internal consistency of Section B. Since project-based learning has been associated with higher achievement than traditional instruction (Chen & Yang, 2019), the low reported use of projects for this topic points to an area where support may be needed.

Second, teachers reported integrating social and environmental aspects more often than technological ones. Electrical safety and energy saving are directly linked to the topic and to students' daily lives, and they can be addressed through brief examples during lessons. Links to microcontrollers, sensors and the Internet of Things require equipment, technical knowledge and time for students to build and test devices. In terms of the currents described by Pedretti and Nazir (2011), the reported practice appears closer to mentioning social and environmental relevance than to the application and design current, in which students design technological solutions. The high agreement with item C4, which describes STSE integration as necessary but difficult, supports this reading: teachers may connect content to real contexts at the level of examples, while organising full STSE activities remains difficult. Vietnamese studies have proposed detailed STSE processes for related topics such as power sources and energy (Lê, 2025a, 2025b) and renewable energy (D. L. Nguyễn et al., 2023). The present data suggest that such designs have not yet become common practice for this topic among the surveyed teachers. The emphasis on social and environmental relevance may also reflect the attention given to education for sustainable development in Vietnamese schools, which has been examined in upper secondary settings by Hà and Bui (2024). Strengthening the technological dimension would bring classroom practice closer to the full range of STSE relationships and would make better use of the technological content that the topic offers. Because the frequency of integration was self-reported, classroom observation or analysis of lesson plans would be needed to confirm the level of integration.

Third, teachers rated students' ability to explain the practical significance of the content higher than their ability to design experiments and to collect and process data. The lowest-rated capability, collecting and processing data, had no responses at the strongly agree level. This pattern corresponds to the reported teaching practice: when experiments and projects are organised infrequently, students have fewer opportunities to practise investigation. The persistent conceptual difficulties with direct current circuits documented by Engelhardt and Beichner (2004) also suggest that explanation-oriented teaching may not be sufficient for conceptual understanding. Q. L. Nguyen et al. (2025) reported that an STSE intervention on a related electricity topic improved lower secondary students' competence in conducting investigations and linking science to practice. Similar interventions at the upper secondary level could target the capabilities that teachers rated lowest in this study. The ratings in Section D reflect teachers' perceptions rather than direct measures of student competence and should be interpreted with this limitation in mind.

Fourth, there was a gap between awareness of the STSE model and readiness to adopt it. Only about two in five teachers reported familiarity with the model, whereas about seven in ten were willing to adopt it with materials and training and believed it could develop scientific competence better than traditional methods. A similar combination of positive perceptions and limited procedural knowledge was reported among lower secondary teachers by Lê et al. (2026). The reliability analysis of Section E, in which E1 behaved differently from E2 and E3, is consistent with this gap. For teachers who were unfamiliar with the model, beliefs

about its effectiveness may be based on a general image of project-based learning rather than on specific knowledge of STSE. Intervention studies conducted in Vietnam (Q. L. Nguyen et al., 2025, 2026) could serve as local examples in professional development, allowing teachers to see how STSE projects are designed and assessed in their own curriculum context.

These findings have several implications for supporting STSE implementation in upper secondary physics. Topic-specific resources, including lesson plans, worksheets and assessment rubrics, may reduce the preparation time that teachers reported as a constraint. Projects using low-cost sensors and microcontrollers, such as a sensor-based fire alarm device, could strengthen the technological dimension of STSE while connecting to electrical and fire safety. Activities requiring students to measure, record and analyse data could address the capability that teachers rated lowest. Professional development could focus on the instructional process of the STSE model and on designing real-world situations, as these were areas of limited knowledge in both this study and previous research. Because Lê et al. (2026) also identified the development of competence assessment tools as a difficulty, such programmes could include criteria and rubrics for assessing students' investigative capabilities during STSE projects. Support of this kind would address both the constraints and the knowledge gap reported by the teachers in this study.

6. LIMITATIONS AND FUTURE RESEARCH

This study has several limitations. The sample of 55 teachers was recruited through convenience sampling, and most participants were under 40 years old; the findings may not represent physics teachers in other regions or age groups. All data were self-reported, and responses about practice and integration may be influenced by social desirability. Section D measured teachers' perceptions of student competence rather than students' actual performance. Section B had modest internal consistency, and its items were interpreted individually. Some responses with multiple selected options were treated as missing, which reduced the number of valid responses for several items. Future research could combine teacher surveys with classroom observation, lesson plan analysis and direct assessment of students' scientific competence, and could evaluate the effects of STSE-based projects on the topic "Electric current and circuits" at the upper secondary level.

7. CONCLUSION

This survey of 55 Vietnamese upper secondary physics teachers indicates that lecturing combined with problem solving remains common when teaching "Electric current and circuits", while experiments and project-based learning are used less frequently and time and facility constraints are widely reported. Teachers link the topic more often to social and environmental issues than to modern technology. They rate students' investigative capabilities, especially data collection and processing, lower than their ability to explain the practical significance of the content. Although fewer than half of the teachers are familiar with the STSE model, most are willing to adopt it with materials and training. These findings suggest that topic-specific STSE resources, technology-oriented low-cost projects, and professional development focused on the instructional process of the model may support the implementation of STSE in upper secondary physics.

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