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Teaching equipment and assessment methods, techniques, and tools used by biology teachers to enhance living world understanding competency for high school students in the Vietnamese Mekong Delta

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Abstract

The shift in teaching objectives from a content-focused approach to a competency-based one has posed numerous challenges for educators, including Biology teachers in the Mekong Delta. The study aims to investigate teachers' current utilization of various teaching equipment and assessment methods, techniques, and tools to enhance high school students' comprehension of the natural world. The research was carried out at several high schools in the Mekong Delta, and the survey participants included teachers teaching in these high schools. The survey comprised 60 teachers of varying ages and seniority, with 24 males (40%) and 36 females (60%). A cross-sectional survey model utilizing quantitative methods was used to conduct the survey. Results indicate that high school teachers can access numerous teaching equipment and assessment techniques, methods, and tools to evaluate student performance. The computer is the leading equipment used by all participants, and mindmap, evaluation through learning products, and learning products are primarily used by participants as assessment techniques, methods, and tools, respectively. Some teachers have combined and utilized these equipment, techniques, methods, and tools to help students develop their understanding of the living world. However, a few teachers have yet to recognize the significance of evaluating student performance and have been ineffective in employing these assessment tools. Therefore, it is necessary to introduce and innovate teaching equipment and assessment techniques, methods, and tools for students that align with contemporary educational trends. Teachers require training and skill enhancement in evaluating student performance to improve the quality of education and advance student capacity.

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Introduction

As per the Vietnamese dictionary, "learning" is defined as the process of exploring and investigating specific issues to acquire knowledge and understanding (Phe & Luong, 1997). According to Attenborough (1984), our planet teems with countless species, ranging from minuscule bacteria to colossal blue whales, collectively constituting the "Living World," which essentially denotes a world endowed with life. Within general education programs, competence is described as an individual's capacity to proficiently execute a particular activity by amalgamating their knowledge, skills, and personal attributes, such as interest, belief, and willingness. These attributes are cultivated through inherent qualities as well as the process of learning and training. Competence takes shape and evolves through practical engagement, with its effectiveness being observable and quantifiable. From these concepts, it becomes evident that competence is not solely an innate quality but rather a synergy of various factors. It only becomes evident and meaningful when individuals apply it to resolve issues or accomplish tasks in their professional or everyday lives, underscoring its intimate connection to practical application.

The Vietnam General Education Program is designed to nurture learners' qualities and capabilities by imparting fundamental, practical, and contemporary knowledge and skills. It seeks to balance virtue, wisdom, and aesthetics. The program strongly emphasizes the practical application of acquired knowledge and skills to address challenges in both academic pursuits and daily life. This approach is highly integrated in lower-level classes and progressively becomes more specialized in higher-level courses. The program employs educational methods and organizational strategies to achieve these objectives that encourage each student's initiative and potential. Assessment methods are aligned with academic goals, ensuring a congruent approach to attaining these objectives (Ministry of Education and Training [MET], 2018).

Biology is categorized as an experimental science and is a popular subject within the natural sciences group in career-oriented education. The biological world, which is closely related to students' daily life, is the primary focus of research in Biology. The advancements in Biology are bridging the gap between fundamental theoretical knowledge and practical application. The Biology subject in high school aims to cultivate students' abilities, including biological awareness, learning about the living world, and applying their knowledge and skills in practical situations. Specifically, the student's ability to learn about the living world involves several steps, such as identifying relevant problems related to the living world, formulating hypotheses, planning and implementing tests to validate ideas, and reporting and discussing research findings. This information is based on the General Education Program - Biology subject, released by MET (2018).

Besides utilizing teaching methods, implementing teaching techniques also plays a vital role in enhancing teachers' creativity and positivity. Teaching techniques refer to how teachers and students employ small-scale situations to manage and regulate the teaching process. These techniques constitute the minor components of teaching methods and include general strategies and specific techniques unique to each way, such as questioning techniques in dialogues. To foster learners' dynamism and innovation, educators need to concentrate on developing and applying teaching techniques, such as brainstorming, lightning flash, fish tank, mind maps, and skill tablecloth art.

Literature Review

Suitable methods, forms, and tools are necessary for evaluating and testing each specialized competency. In terms of problem-solving and creativity, several theories and research frameworks have been developed by Australian Curriculum, Assessment and Reporting Authority [ACARA] (2016); O'Neil and Schacter (1997); OECD (2013); Patrick and Esther (2013); Polya (1965), which have drawn the attention of numerous scholars. Tram (2019) has explored the theoretical and practical aspects of applying active teaching methods in Science 4 to cultivate students' capacity for exploring the natural world. This approach involves using discovery, inquiry, and problem-solving techniques to develop primary school students' ability to analyze and uncover the natural world's secrets.

While addressing the topic of water exchange in the realm of Natural Science at the Secondary School level, Le proposed a systematic approach to enhance students' biological aptitude through a series of questions. This process encompasses six key steps: Step 1: Structure and Content Analysis: Begin by scrutinizing the structure and content of chapters, articles, and topics related to the subject matter. Step 2: Educational Goals Determination: Establish clear teaching and learning objectives specific to Biology. Step 3: Content Identification: Identify the core knowledge content suitable for conversion into inquiry-based questions. Step 4: Data Gathering: Gather relevant data to inform the design of the question system.

Step 5: Question System Design: Utilize the gathered insights to craft questions tailored to foster and assess biological competence meticulously. Step 6: Testing, Evaluation, and Adjustment: Conclude the process by rigorously testing, evaluating, and refining the question system to optimize its effectiveness (Le, 2021).

In teaching the reproduction topic in 11th-grade Biology, Ninh emphasized that learners engage in active and proactive exploration and discovery. This involves asking questions, gathering data, conducting investigations, and analyzing information to seek and acquire new knowledge actively. To foster students' capacity for discovery and exploration, Ninh employed the 5E instructional model. This model encompasses four primary competency components, each with corresponding sub-competencies. Throughout exploration and discovery activities, students take on the role of scientists, organizing their findings according to predefined guidelines with guidance, support, and teacher supervision. These activities aim to cultivate scientific research skills, promote the development of scientific thinking, instill an understanding of how to apply biological knowledge in real-world scenarios and nurture students' interest in learning while fostering a rigorous attitude toward science (Ninh, 2020).

In their study on water and mineral exchange in plants, Ha et al. proposed a set of principles and procedures for evaluating the capacity to explore the natural world. This assessment can be structured as a four-step process: (1) Research Planning: The first step involves planning the assessment process; (2) Designing Appropriate Tools: Proceed to create suitable assessment tools tailored to the specific objectives; (3) Seeking Expert Opinions: Seek input and guidance from experts in the field to refine the assessment approach; and (4) Finalizing the Assessment Tool: Complete and finalize the assessment tool for use. The assessment of the ability to explore the living world encompasses evaluating skills such as identifying research problems arising from practical situations, formulating research questions, constructing hypotheses (planning and executing experiments to test these hypotheses), comparing results with initial assumptions, drawing conclusions, and effectively communicating findings through reports, including discussions and explanations. These abilities can be assessed by either teachers or students and can be evaluated through feedback or scoring. Appropriate assessment tools may include essay questions, multiple-choice questions, practical exercises, experimental tasks, or assessment sheets such as checklists, scales, or rubrics based on specific criteria. The choice of assessment format, timing, and tools depends on various factors, including educational objectives, teaching content, instructional methods, student learning outcomes, and the capabilities of educators and learners, as well as other contextual factors (Ha et al., 2023). The previous research findings highlight that the teaching approach for nurturing the capacity to explore the natural world has primarily focused on developing instructional strategies and organizing teaching processes. However, there has been limited emphasis on assessing the effectiveness of these teaching methods, particularly within the context of the Mekong Delta in Vietnam. Consequently, there is a pressing need for further research in this area.

Methodology

The study utilized a cross-sectional survey model incorporating quantitative research approaches. The research instrument employed was a questionnaire adapted from a questionnaire by Pham and Nguyen (2011). The Likert scale was used to measure consent, satisfaction, or response based on the methodology reported by Allen and Seaman (2007). The questionnaire consists of two parts: general information and survey content. The Likert scale range of 5 was applied with an interval of (5-1)/5 = 0.8 to provide relatively accurate judgments about the level of agreement, as (Narli, 2010); Yavuz et al. (2013). The scale was defined as follows: $1.0 \leq M < 1.8$ (never/strongly disagree), $1.8 \leq M < 2.6$ (rarely/disagree), $2.6 \leq M < 3.4$ (occasionally/confuse), $3.6 \leq M < 4.2$ (regularly/agree), and $4.2 \leq M \leq 5.0$ (very regularly/strongly agree).

Sample collection: The survey was administered via Google Forms, with samples randomly gathered from 40 high schools in the Mekong Delta region of Vietnam. Before conducting the official survey, the form underwent a design adjustment phase, as recommended by Dinh et al. (2011a; 2011b).

Measuring questionnaire reliability: The Cronbach Alpha method, developed by Cronbach (1951), was utilized to assess the reliability of the survey questionnaires. This method has been successfully employed in evaluating the quality of human resources trained at Can Tho University, according to the requirements of enterprises in the Mekong Delta region, as reported by (Quan et al., 2012).

Data analysis: Data were encrypted and processed using SPSS v.21 after collection. Mann-Whitney U and Kruskal Wallis H tests were applied to assess differences in opinions between male and female teachers and among five seniority groups (1–5 years, 6–10 years, 11–15 years, 16–20 years, 21–25 years, and 26–30 years), respectively. The significance level was set at $p < .05$.

Results and Discussion

Reliability of the Questionnaire

The questionnaire is highly reliable, as reflected by a Cronbach Alpha coefficient of 0.98. This value exceeds the criterion coefficient of 0.6, a commonly accepted threshold for measuring reliability. The analysis shows a coefficient of 0.98, indicating that the questions in the questionnaire are highly correlated and consistently measure the same underlying construct.

General Information of Survey Participants

Of the 60 teachers who participated in the survey, 24 were males, while 36 were females, representing 40 percent and 60 percent of the total respondents. Regarding seniority, the highest proportion of teachers fell within the 11–15 years and 6–10 years of experience categories, accounting for 31.7 percent and 25.0 percent, respectively. Teachers with 1–5 years and 16–20 years of experience made up 18.30 percent and 16.70 percent, respectively. Teachers with 21–25 years and 26–30 years of experience had less than 5.00 percent representation in the survey. In simpler terms, the survey had a total of 60 teachers participating. More female teachers (60%) participated than male teachers (40%). Most teachers had between 6 and 15 years of experience, while those with more than 20 years of experience were less represented in the survey.

Equipment, Techniques, Methods, and Tools Used by Teachers to Assess Students' Living World Understanding Competency

Equipment used by teachers to assess students' ability to explore the living world

Teaching equipment is an essential component of the teaching process, and its absence can hinder the smooth conduct and overall effectiveness of teaching activities (Sam, 2020). As per Article 1 of the Ministry of Education's Regulation on Educational Equipment (41/2000/QDBGDDT), educational equipment encompasses equipment for classroom instruction and learning, laboratory equipment, fitness equipment, sports equipment, music-graphic equipment, and other equipment found in school workshops, gardens, and traditional rooms. These resources enhance the quality of Teaching and learning, thereby contributing to realizing comprehensive educational goals (MET, 2007).

The survey results on the teaching equipment most commonly used by teachers indicate that computers are prevalent in the teaching process, with a usage rate of 100 percent. Additionally, boards and chalk/pencils are utilized by 95 percent of teachers, owing to their widespread usage and familiarity. Visual aids such as televisions, speakers, and microphones are also employed by a considerable proportion of teachers, as indicated by a survey rate of 91.7 percent. Moreover, aids utilized for demonstration and illustration purposes, including pictures, photos, and videos, are frequently used by 85 percent of teachers. As many as 70 percent of teachers employ experimental aids such as microscopes and magnifying glasses. However, projectors and microscope slides are less frequently used, with 58.3 percent and 50 percent usage rates, respectively (Figure 1).

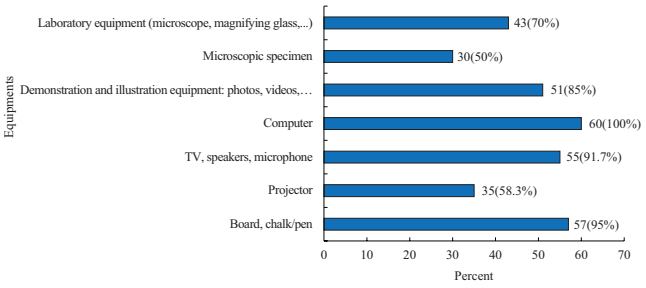

Figure 1 The equipment that teachers often use in teaching

Teachers heavily rely on various equipment such as pictures, videos, computers, speakers, televisions, microphones, whiteboards, chalk, and pens during the teaching process as they are common and necessary devices in the classroom. This trend is further reinforced by Circular No. 39/2021/TT-BDGĐT issued by the MET, which mandates minimum teaching equipment at the upper secondary level (MET, 2021). Consequently, schools are investing in and purchasing teaching equipment to cater to the needs of teachers. However, when it comes to laboratory equipment and microscopy, the usage rate is comparatively low since these are specialized tools for practical teaching that only take up a small portion of the subject program. This observation aligns with the findings of Le's research in 2017, which aimed to understand the current situation and suggest ways to enhance the efficacy of using modern visual teaching aids at Hai Thanh Secondary School, Dong Hoi, Quang Binh, Vietnam (Le, 2017).

Assessment techniques used by teachers to evaluate students' ability to explore the living world

Instructional technology refers to teachers' methods, systems, and approaches to impart students' knowledge, skills, and principles. These techniques include various strategies, resources, media, and instructional methods used in the classroom. A survey on teaching techniques used by teachers indicates that there are several different techniques employed. The most commonly used technique among teachers is mind maps, with a survey rate of 98.3 percent. Following that, "pieces of the puzzle," "brainstorming-brainstorming," and "tablecloths" are the following three techniques that many teachers use, with rates of 73.3 percent, 68.3 percent, and 65 percent, respectively. The "gallery" and "KWL" techniques have similar application rates among teachers, 40 percent and 43.4 percent, respectively. The survey also shows that teachers use the "microscopic slide" and "lightning bolt" techniques relatively infrequently, with rates of 31.7 percent and 26.7 percent, respectively. Finally, the "ball bearing" technique has the lowest use percentage among teachers, at only 3.3 percent. This variation in technique usage is due to differences in how teachers approach teaching. Mind maps, animations, brainstorming, tablecloths, and puzzle pieces are commonly used because they are techniques that many teachers are familiar with and use regularly. In contrast, teachers use galleries, microscope slides, KWL, ball bearings, and lightning bolts less frequently (Figure 2).

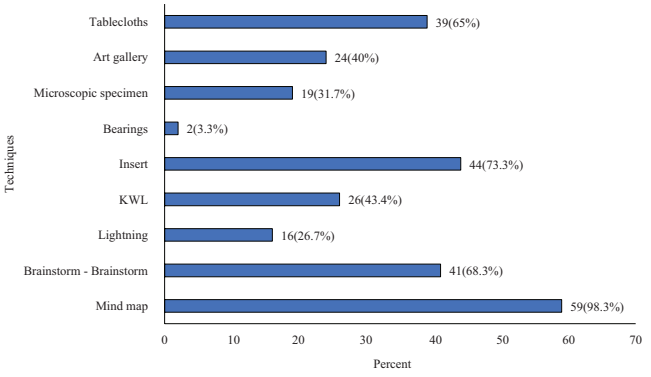

Figure 2 Techniques used to develop students' living world understanding competency

Teachers must adapt and employ active teaching techniques while skillfully and creatively integrating traditional teaching methods, techniques, and hands-on experiences into their classrooms. However, do teachers effectively use teaching techniques that cater to the needs of learners? In a study conducted by Nguyen (2020), teachers use specific teaching techniques, revealing that the "Statement and Solve Problems" technique is used most often (31.1%), followed by the Tablecloth technique (28.7%), Technical Group (26.2%), Q&A technique (21.3%), Brainstorming technique (14.8%), Piece technique (12.3%), Mind Mapping technique (8.2%), Project techniques (1.6%), and Angular techniques (0.8%). Additionally, the author identified several issues, including that current teachers do not fully comprehend and implement modern teaching techniques and that many teachers still prefer traditional teaching methods such as lecturing and copying.

The utilization of teaching techniques by teachers is not optimal. Consequently, teachers need to be more proactive in using innovative teaching techniques to enhance the learning outcomes of their students. However, there are still many teachers who prioritize using traditional teaching methods. For instance, according to the survey by Nguyen (2020), 17.2 percent of teachers still use conventional teaching methods, where teachers listen to students and are still the center of educational activities, which is not well-received by learners. Similarly, in the survey results of Tham (2019), 10.7 percent of teachers still use traditional teaching methods, 37.4 percent of teachers opt for the communication method with their students, 30.9 percent use the Mind Mapping technique, and 20.9 percent use the role Playing technique during teaching. Nonetheless, most teachers understand the significance of modern teaching methods and actively apply them during their lectures, which has also been confirmed.

Assessment methods used by teachers to evaluate students' ability to explore the living world

Evaluation is a crucial aspect of teaching as it allows for assessing students' progress and provides feedback to teachers on the effectiveness of their teaching methods. Teachers use five effective methods to evaluate their students during instruction. The survey results indicate that all teachers (100%) assess students through their learning process outcomes. Assessment through written tests and direct question and answer is also frequently employed by most teachers, with a rate of 91.7 percent and 90 percent, respectively. Furthermore, 86.7 percent of teachers evaluate students by observing their performance during teaching. However, the academic record assessment method has the lowest rate of 61.7 percent, though still used by more than half of the teachers, signifying that teachers utilize various assessment methods to evaluate their students' performance (Figure 3).

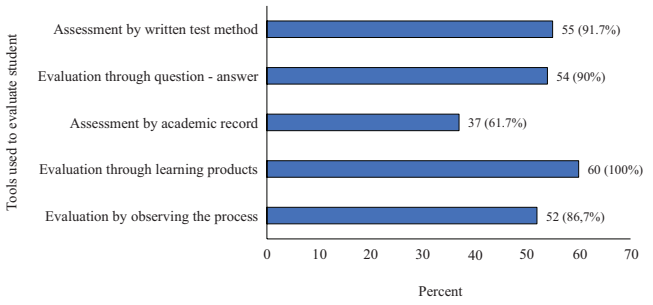

Figure 3 Assessment methods used to evaluate students' living world understanding competency

The Portfolio assessment method has the lowest rate of use in this survey because it is not an assessment tool (Spodek & Saracho, 1997) but rather a collection of student work products that demonstrate progress, effort, and achievement in one or more activities at a specific stage (Arter & Spandel, 1992; Gelfer & Perkins, 1996). According to Shores and Grace (1998), the Portfolio is evaluated as a form of performance assessment based on the collected products, and the results are effectively used to adjust and develop educational programs (Gronlund, 2019). However, there are some limitations to using the Portfolio method. For example, it is a continuous integrated assessment method that requires teachers' time and capacity. Additionally, when teachers have many students or teach multiple classes, it can be challenging to follow up and ensure the content, leading to difficulties in ensuring the reliability and objectivity of assessment results. As a result, teachers rarely use this method to evaluate students, which is consistent with the findings of the study "Theory and practice of using the portfolio assessment tool in teaching preschool children." (Han, 2014).

The utilization of effective assessment methods is crucial for both teachers and students in achieving educational goals. The survey results reveal that most teachers consider the assessment through learning products the most effective method (74.6%). Furthermore, many teachers also acknowledge the effectiveness of the observational evaluation. Some teachers prefer a combination of various methods to capitalize on the advantages of each method. Testing and evaluation activities are essential elements of teaching theory and practical tools for teachers to monitor learners' progress toward educational goals. Moreover, it is vital to academic management and quality assurance in teaching and learning.

Assessment tools used by teachers to evaluate students' ability to explore the living world

Most teachers use the "Learning Product" tool for assessment, with a rate of 96.7 percent. "Test questions" and "Self-reported questions or objective tests" are also popular among teachers, with a rate of 90 percent and 93.3 percent, respectively. Another common assessment tool teachers use is "exercises," with a rate of 80 percent. However, tools such as "criteria assessment sheets," "checklists," "learning records," and "evaluators" are not as widely used in the assessment process. These tools have survey rates of 51.7 percent, 50 percent, 50 percent, and 45 percent, respectively (Figure 4).

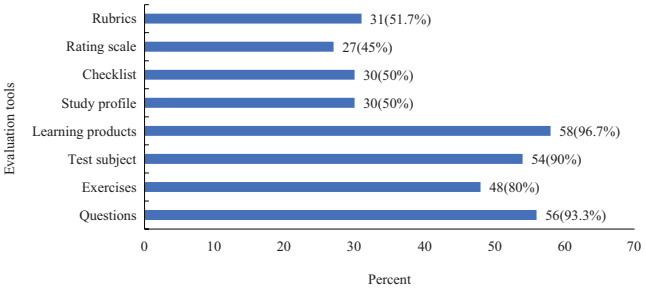

Figure 4 Assessment tools used to evaluate students' living world understanding competency

Teachers tend to use traditional assessment tools, such as learning products, tests, exercises (in video or text format), and questions (including essays and objective tests), because they are familiar with these methods and bring convenience, making them easy to implement across different subjects. However, process assessment tools like rubrics, rating scales, checklists, and learning records are less commonly used, as they require close monitoring of each student, making the assessment process time-consuming and effort-intensive. Furthermore, large class sizes and varying student abilities can challenge these assessment tools. These difficulties align with the findings of Phuong's study on testing and assessing learning outcomes in natural science subjects at junior high schools in District 11, Ho Chi Minh City, using a competency-based approach (Phuong, 2019).

In assessing students, teachers must choose suitable assessment tools that match their abilities. According to the survey, many teachers believe that "learning product" effectively develops students' abilities. The second most commonly used tool is "test questions" or "essay questions." Some teachers suggest using tools that focus on "image/text channels, practical/experimental exercises, situations, and projects"

to develop students' understanding of the world. A few teachers suggest using a combination of different assessment tools to develop students' abilities better.

Building a Scale to Assess Students' Ability to Understand the Living World

According to the survey results, most participating teachers regularly assess the criteria identified by the research team as indicative of the ability to learn about the living world. These criteria are Q161 (with a mean of 4.12±0.58 *SE*), Q162 (3.97±0.61 *SE*), Q163 (3.67±0.71 *SE*), Q164 (3.67±0.82 *SE*), and Q165 (3.75±0.84 *SE*) (Table 1). In simpler terms, the survey revealed that most teachers regularly use specific criteria to assess their students' learning about the living world. The teachers gave high mean scores for Q161 and Q162, indicating that they frequently evaluate these criteria. The teachers gave lower mean scores for Q163, Q164, and Q165, suggesting they consider these criteria less often. The standard errors measure the variability in the scores for each criterion.

The evaluation levels of male and female teachers for criteria Q161-Q165 are almost the same and not statistically significant (Mann-Whitney U, $p > .05$, Table 1). The assessment levels of teachers with different seniorities (1–5 years, 6–10 years, 11–15 years, 16–20 years, 21–25 years, 26-30 years) are not significantly different when evaluating criteria and building a scale to assess students' ability to understand the living world (Kruskal-Wallis H, $p > .05$). This means that the teacher's seniority level does not affect their ability to assess the criteria effectively. The test examined the differences among groups of teachers with different levels of seniority for each criterion, and the results showed no significant differences among them (Table 2).

The teachers' views on the criteria for building a scale of students' ability to understand the living world are similar, regardless of gender or seniority. Constructing such a scale is a complex task that demands multiple skills. The surveyed teachers commonly use the research team's proposed five criteria for building the scale since they are based on the steps of scientific research and biology is an experimental subject with real-life applications. Therefore, these criteria satisfy the teachers' assessment requirements for evaluating students' abilities.

Table 1 Evaluation level of the selection of criteria for the assessment scale of students' ability to understand the living world according to sex

Code	Contents	Mean±*SE*	Assessment level	Female	Male	Mann-Whitney U
Q161	Proposing problems related to the living world: posing questions related to the problem, analyzing the context to propose the problem, and using their language to express the problem	4.12±0.58	Regularly	3.86±0.13	4.04±0.15	Z = -0.92, p = .36
Q162	Make judgments and build hypotheses: analyze the problem to state the judgment; develop and state the research hypothesis	3.97±0.61	Regularly	3.67±0.16	3.63±0.16	Z = -0.64, p = .52
Q163	Making an implementation plan: building a logical framework for research content; selecting appropriate methods (observation, experiment, investigation, interview, data review,...); developing a research plan	3.67±0.71	Regularly	3.81±0.15	4.04±0.14	Z = -0.81, p = .42
Q164	Implement the plan: collect and store data from the results of overview, experiment, and investigation; evaluate results based on analysis, process data with simple statistical parameters; compare the results with the hypothesis, explain, draw conclusions, and adjust (if necessary); Suggest ideas and recommendations apply research results or issues for further research	3.67±0.82	Regularly	4.58±0.09	4.58±0.10	Z = -0.12, p = .90
Q165	Write, present reports, and discuss: use of language, drawings, diagrams, and tables to express the research process and results; write research reports; cooperate with partners by actively listening and respecting the opinions and evaluations given by others to actively absorb and explain, critique, and defend research results convincingly	3.75±0.84	Regularly	4.44±0.10	4.38±0.13	Z = -0.39, p = .70

Note: $1.0 \le M < 1.8$: Never; $1.8 \le M < 2.6$: Rarely; $2.6 \le M < 3.4$: Occasionally; $3.4 \le M < 4.2$: Regularly; $4.2 \le M \le 5.0$: Very regularly

Table 2 Evaluation level of the selection of criteria for the assessment scale of students' ability to understand the living world according to seniority

Code	Seniority (year)						Kruskal-Wallis H
	1–5	6–10	11–15	16–20	21–25	26–30	(*df* = 5)
Q161	4.00±1.00	3.91±0.16	4.27±0.15	3.58±0.21	4.10±0.23	4.00±0.58	$\chi^2 = 6.18$, $p = .29$
Q162	4.00±1.00	3.64±0.20	4.00±0.17	3.32±0.25	3.70±0.26	3.67±0.33	$\chi^2 = 4.57$, $p = .47$
Q163	3.50±1.50	3.91±0.21	4.27±0.15	3.58±0.23	4.00±0.21	4.00±0.00	$\chi^2 = 5.36$, $p = .37$
Q164	5.00±0.00	4.55±0.16	4.67±0.13	4.42±0.14	4.70±0.15	4.67±0.33	$\chi^2 = 3.70$, $p = .59$
Q165	5.00±0.00	4.18±0.23	4.33±0.16	4.37±0.14	4.70±0.15	4.67±0.33	$\chi^2 = 6.24$, $p = .28$

Note: $1.0 \le M < 1.8$: Never; $1.8 \le M < 2.6$: Rarely; $2.6 \le M < 3.4$: Occasionally; $3.4 \le M < 4.2$: Regularly; $4.2 \le M \le 5.0$: Very regularly; Q161: Proposing problems related to the living world: posing questions related to the problem, analyzing the context to propose the problem, and using their language to express the problem; Q162: Make judgments and build hypotheses: analyze the problem to state the judgment; develop and state the research hypothesis; Q163: Making an implementation plan: building a logical framework for research content; selecting appropriate methods (observation, experiment, investigation, interview, data review,...); developing a research plan; Q164: Implement the plan: collect and store data from the results of overview, experiment, and investigation; evaluate results based on analysis, process data with simple statistical parameters; compare the results with the hypothesis, explain, draw conclusions, and adjust (if necessary); Suggest ideas and recommendations apply research results or issues for further research; Q165: Write, present reports, and discuss: use of language, drawings, diagrams, and tables to express the research process and results; write research reports; cooperate with partners by actively listening and respecting the opinions and evaluations given by others to actively absorb and explain, critique, and defend research results convincingly

Most teachers believe teacher-led activities effectively enhance students' knowledge of the natural world, which is indicated by mean scores obtained for the following questions: Q171 (4.02±0.62 *SE*), Q172 (3.85±0.66 *SE*), Q173 (3.68±0.68 *SE*), Q174 (3.60±0.76 *SE*), and Q175 (3.67±0.80 *SE*) (Table 3). The mean scores for all the questions are above 3, indicating that most teachers believe that teacher-led activities effectively enhance students' knowledge of the natural world. The highest mean score is obtained for Q171, suggesting that teachers firmly believe in the effectiveness of teacher-led activities in enhancing students' knowledge. The lowest mean score is obtained for Q174, indicating that teachers are slightly less confident in the efficacy of teacher-led activities in enhancing students' understanding of this question.

Table 3 Students' participation in activities organized by teachers towards developing their ability to understand the living world according to sex

Code	Content	Mean±*SE*	Assessment level	Female	Male	Mann-Whitney U
Q171	Proposing problems related to the living world: posing questions related to the problem, analyzing the context to propose the problem, and using their language to express the problem	4.02±0.62	Regularly	3.22±0.14	3.25±0.16	Z = -0.13, $p = .89$
Q172	Make judgments and build hypotheses: analyze the problem to state the judgment; develop and state the research hypothesis	3.85±0.66	Regularly	3.69±0.12	3.71±0.15	Z = -0.24, $p = .81$
Q173	: Making an implementation plan: building a logical framework for research content; selecting appropriate methods (observation, experiment, investigation, interview, data review,...); developing a research plan	3.68±0.68	Regularly	4.28±0.09	4.25±0.12	Z = -0.14, $p = .89$
Q174	Implement the plan: collect and store data from the results of overview, experiment, and investigation; evaluate results based on analysis, process data with simple statistical parameters; compare the results with the hypothesis, explain, draw conclusions, and adjust (if necessary); Suggest ideas and recommendations apply research results or issues for further research;	3.60±0.76	Regularly	3.92±0.12	3.88±0.14	Z = -0.20, $p = .84$
Q175	Write, present reports and discuss: use language, drawings, diagrams, and tables to express the research process and results; write research reports; cooperate with partners by actively listening and respecting the opinions and evaluations given by others to actively absorb and explain, critique, and defend research results convincingly	3.67±0.80	Regularly	3.22±0.14	3.25±0.16	Z = -0.13, $p = .89$

Note: $1.0 \le M < 1.8$: Never; $1.80 \le M < 2.6$: Rarely; $2.6 \le M < 3.4$: Occasionally; $3.4 \le M < 4.2$: Regularly; $4.2 \le M \le 5.0$: Very regularly

The ratings for questions Q171-Q176 were not significantly different between male and female teachers (Mann-Whitney U, $p > .05$, Table 3) and among the various seniority groups (Kruskal-Wallis H, $p > .05$, Table 4). In other words, there was no statistically significant difference in how teachers with different experience levels rated the extent to which students participate in teacher-led activities to enhance their knowledge of the natural world.

The survey results indicate that teachers face challenges when teaching students about the living world, and teachers evaluate these challenges at different difficulty levels. The research team identified fundamental challenges in teaching students, including issues with students' attitudes in the classroom, limited facilities, and insufficient time for each lesson, which most teachers agreed with. The mean scores show this agreement for Q182 (3.45±1.03 *SE*), Q183 (3.40±0.98 *SE*), and Q186 (3.42±1.05 *SE*) in Table 5. However, teachers were uncertain about other difficulties hindering teaching, such as student quality, instructional materials, teaching methods, and teaching and capacity development training.

Male and female teachers were compared based on their rating levels for various questions about difficulties teaching students to comprehend the living world. The results show no significant differences between the two groups for Q181–Q187 (Mann-Whitney U, $p > .72$, Table 5). This suggests that male and female teachers have similar perceptions and experiences regarding the identified challenges in teaching students about the living world. Similarly, no significant differences were found in the rating levels between teachers with different levels of seniority (1–5 years, 6–10 years, 11–15 years,

Table 4 Evaluation level of the selection of criteria for the assessment scale of students' ability to understand the living world according to seniority

Code	Seniority (year)						Kruskal-Wallis H ($df = 5$)
	1–5	6–10	11–15	16–20	21–25	26–30	
Q171	4.00±1.00	3.36±0.24	3.27±0.18	3.16±0.22	3.20±0.20	2.67±0.33	$\chi^2 = 3.28$, $p = .66$
Q172	4.00±1.00	3.55±0.25	3.73±0.15	3.79±0.16	3.70±0.26	3.33±0.33	$\chi^2 = 2.64$, $p = .76$
Q173	5.00±0.00	4.27±0.19	4.13±0.13	4.26±0.13	4.40±0.22	4.00±0.00	$\chi^2 = 5.99$, $p = .31$
Q174	4.50±0.50	4.00±0.19	3.67±0.16	3.95±0.18	4.00±0.26	3.67±0.33	$\chi^2 = 3.79$, $p = .58$
Q175	4.00±1.00	3.36±0.24	3.27±0.18	3.16±0.22	3.20±0.20	2.67±0.33	$\chi^2 = 3.28$, $p = .66$

Note: $1.0 \le M < 1.8$: Never; $1.8 \le M < 2.6$: Rarely; $2.6 \le M < 3.4$: Occasionally; $3.4 \le M < 4.2$: Regularly; $4.2 \le M \le 5.0$: Very regularly; Q171: Proposing problems related to the living world: posing questions related to the problem, analyzing the context to propose the problem, and using their language to express the problem; Q172: Make judgments and build hypotheses: analyze the problem to state the judgment; develop and state the research hypothesis; Q173: Making an implementation plan: building a logical framework for research content; selecting appropriate methods (observation, experiment, investigation, interview, data review,...); developing a research plan; Q174: Implement the plan: collect and store data from the results of overview, experiment, and investigation; evaluate results based on analysis, process data with simple statistical parameters; compare the results with the hypothesis, explain, draw conclusions, and adjust (if necessary); Suggest ideas and recommendations apply research results or issues for further research; Q175: Write, present reports and discuss: use language, drawings, diagrams, and tables to express the research process and results; write research reports; cooperate with partners by actively listening and respecting the opinions and evaluations given by others to actively absorb and explain, critique, and defend research results convincingly.

Table 5 Difficulties faced by teachers when teaching in the direction of developing students' ability to understand the living world according to sex

Code	Content	Mean±*SE*	Assessment level	Female	Male	Mann-Whitney U
Q181	Low quality/capacity of students	3.25±0.97	Confuse	3.14±0.13	3.17±0.19	$Z = -0.21$, $p = .83$
Q182	Students' activeness is still not high	3.45±1.03	Agree	2.83±0.15	3.17±0.20	$Z = -1.38$, $p = .17$
Q183	Conditions and facilities have not been met	3.40±0.98	Agree	3.00±0.15	3.08±0.16	$Z = -0.28$, $p = .78$
Q184	There are no specific guidance documents on teaching and developing students' ability to learn about the living world	3.22±1.09	Confuse	2.72±0.16	3.04±0.15	$Z = -1.48$, $p = .14$
Q185	It is difficult to identify effective teaching methods	3.07±1.06	Confuse	2.00±0.00	2.00±0.00	$Z = 0.00$, $p = 1.00$
Q186	Not enough time to organize activities to develop students' ability to understand the living world	3.42±1.05	Agree	1.97±0.03	2.00±0.00	$Z = -0.82$, $p = .41$
Q187	Not being trained in teaching to develop students' ability to understand the living world	2.97±1.15	Confuse	1.69±0.08	1.75±0.09	$Z = -0.46$, $p = .64$

Note: $1.0 \le M < 1.8$: Strongly disagree; $1.8 \le M < 2.6$: Disagree; $2.6 \le M < 3.4$: Confuse; $3.4 \le M < 4.2$: Agree; $4.2 \le M \le 5.0$: Strongly agree

16–20 years, 21–25 years, and 26–30 years) for various questions related to difficulties in teaching students to comprehend the living world. The statistical tests used were Kruskal-Wallis H tests, which assess the differences in median ratings among the different groups. The p-values for all questions were insignificant, indicating no differences in the rating levels among teachers with varying experience levels, e.g., Q181–Q187 (Kruskal-Wallis H, $p > .05$, Table 6). This suggests that the identified challenges in teaching students to comprehend the living world are consistent across teachers with different experience levels.

Implementing a teaching model to develop students' understanding of the living world comes with challenges and difficulties, especially during the initial stages. According to the survey, most teachers face challenges related to factors such as low student motivation, inadequate infrastructure, and lack of time for organizing activities that aid in developing students' ability to learn about the living world. The biggest obstacle is the time required for teaching and developing this ability, which may force teachers to work overtime if not given adequate flexibility. As a result, many teaching methods with several advantages are challenging to incorporate into teaching practices in Vietnam. Furthermore, careful preparation and planning are crucial for attracting students to actively participate in learning about the living world. Finally, developing teaching competence requires hands-on activities and real exploration, which may require significant physical and financial resources. These findings are consistent with a study conducted by Trinh et al. (2011).

Conclusions and Recommendations

The survey included a total of 60 teachers with different ages and levels of experience, comprising 24 male teachers (40 percent) and 36 female teachers (60 percent). The survey utilized a cross-sectional model that incorporated quantitative methods. The research findings indicate that high school teachers can access several teaching equipment, assessment techniques, methods, and tools for students' abilities. Some teachers have successfully utilized and combined these teaching equipment and assessment methods, techniques, and tools to evaluate their students and assist them in developing their comprehension of the natural world. However, a few teachers have not yet grasped the significance and importance of assessing their student's abilities, and as a result, they have not effectively used these assessment tools.

There is a solid need to update teaching resources and assessment methods in line with current education trends. Teachers should receive training to improve their ability to assess student performance and enhance education quality. Conduct workshops to provide educators with teaching materials and evaluation strategies, including digital literacy. Promote innovative assessment techniques like mind mapping and project-based assessments, and establish mentorship programs among teachers for practical tool implementation. Stress the importance of ongoing student assessment and timely feedback. Encourage educators to stay updated on evolving educational trends and research. Lastly, provide administrative support and allocate resources for these initiatives to ensure success.

Table 6 Evaluation level of the selection of criteria for the assessment scale of students' ability to understand the living world according to seniority

Code	Seniority (year)						Kruskal-Wallis H ($df = 5$)
	1–5	6–10	11–15	16–20	21–25	26–30	
Q181	4.00±1.00	3.27±0.24	3.20±0.14	3.11±0.21	3.20±0.29	2.00±0.00	$\chi^2 = 8.36$, $p = .14$
Q182	3.50±1.50	3.00±0.13	3.20±0.17	2.84±0.26	3.00±0.33	2.00±0.00	$\chi^2 = 6.29$, $p = .28$
Q183	3.50±0.50	3.27±0.19	3.27±0.15	2.79±0.22	3.10±0.28	2.00±0.58	$\chi^2 = 8.93$, $p = .11$
Q184	3.00±1.00	3.27±0.24	3.00±0.17	2.58±0.22	2.90±0.35	2.00±0.00	$\chi^2 = 9.32$, $p = .10$
Q185	2.00±0.00	2.00±0.00	2.00±0.00	2.00±0.00	2.00±0.00	2.00±0.00	$\chi^2 = 0.00$, $p = 1.00$
Q186	2.00±0.00	2.00±0.00	2.00±0.01	2.00±0.00	1.90±0.10	2.00±0.00	$\chi^2 = 5.00$, $p = .42$
Q187	1.50±0.50	1.91±0.09	1.80±0.11	1.58±0.12	1.70±0.15	1.67±0.33	$\chi^2 = 4.73$, $p = .45$

Note: $1.0 \le M < 1.8$: Never; $1.8 \le M < 2.6$: Rarely; $2.6 \le M < 3.4$: Occasionally; $3.4 \le M < 4.2$: Regularly; $4.2 \le M \le 5.0$: Very regularly; Q181: Low quality/capacity of students; Q182: Students' activeness is still not high; Q183: Conditions and facilities have not been met; Q184: There are no specific guidance documents on teaching and developing students' ability to learn about the living world; Q185: It is difficult to identify effective teaching methods; Q186: Not enough time to organize activities to develop students' ability to understand the living world; Q187: Not being trained in teaching to develop students' ability to understand the living world

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Conflict of Interests

The authors declare no potential conflicts of interest concerning the research.

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