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A process for developing a system of varied objective physics questions: a case study on "electric current and electric circuits" aligned with vietnam's 2025 high school graduation examination

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ABSTRACT

The 2018 General Education Curriculum of Vietnam adopts competency-based principles for fully implementing the 2025 High School Graduation Exam, which demands alternative assessment methods. The study investigates how to resolve standardized problems in Physics exam questions connected to competency learning standards by analyzing the "Electric currents and Circuits" topic. The research conducted design-based research (DBR) to develop and test a system of diverse objective questions, including multiple-choice, true/false, and short-answer questions for 175 Grade 11 students at Hai Ba Trung High School in Hue City during the 2024–2025 academic year. The assessment system consists of 93 items that measure competency from basic recall to analysis with an average of 0.55 difficulty and 0.45 discrimination value. Evaluation data confirmed the alignment between this assessment tool and 2025 exam directives. However, examination results revealed that test questions covered only one specific content area, while the varying performance of short-answer questions points toward future improvement needs. The study presents an assessment instrument that physics educators can utilize for evaluation assessment enhancement to support educational reform in Vietnam and serve future scientific education progression.

1. INTRODUCTION

The 2018 General Education Curriculum has introduced a fundamental change in Vietnamese education by emphasizing diverse competency assessments rather than traditional theoretical testing (MOET, 2018). A new test system based on multiple-choice questions (MCQs), true/false (T/F) items, and short-answer (SA) questions will replace the national high school graduation examination in 2025 (MOET, 2024). This assessment transition follows global educational evaluation patterns (Haladyna, 2012) but requires extra attention for diverse objective question standards to preserve scientific measurement accuracy and educational standards.

Physics at the high school level demands assessment systems that align with the new orientation while

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focusing on competency development. Students need to master “Electric Current and Circuits” as it includes fundamental concepts in their national exam and requires essential practical knowledge involving Ohm's Law, resistance theory, and circuit evaluation. The development of diverse objective question systems for Physics remains limited within the country because the standardized procedures needed for the 2025 examination have not been established (Thanh & Thao, 2023).

A new approach is introduced to develop extensive, diverse question systems that integrate 2025 high school graduation exam criteria. The assessment framework employs competency-based principles (Anderson & Krathwohl, 2001) appropriate for Vietnamese educational contexts. It creates a valuable resource that helps teachers instruct students for exams and enhance their Physics competency evaluation outcomes.

2. LITERATURE REVIEW

The 2018 General Education Curriculum in Vietnam transforms educational assessments toward competency development (MOET, 2018), which follows the international assessment movement. A varied objective testing system comprising multiple-choice questions, T/F items, and SA questions is essential to conform to the structure and format of the national high school graduation examination commencing in 2025 (MOET, 2024). This literature review investigates basic concepts regarding competency assessments, objective testing practices, and various objective questions while acknowledging an existing research gap for developing question systems in Grade 11 Physics “Electric Current and Circuits”.

2.1. Theories of Competency Assessment

The research field of competency evaluation depends on Bloom's (1956) taxonomy of cognitive procedures for learning that organizes academic achievement into knowing, understanding, and applying. The assessment tool design process gained increased detail through the model Anderson and Krathwohl (2001) created when they integrated knowledge elements with skills alongside attitudes. Student success at the "knowing" level relies on remembering information. However, they must demonstrate their ability to analyze electricity circuits at the "application" level in Physics. These theories have become standard practices in developing national objective tests, proven through the USA SAT exam and the ONET exam in Thailand (Heyneman, 1987; Ploysangwal, 2018). The author Haladyna (2012) indicates how objective tests enhance testing reliability, but students need diverse questions to reveal their actual learning mastery. According to Burton (2001), flexible assessments provide students with better results when using MCQs along with T/F statements and SA questions to evaluate essential through complex cognitive skills.

2.2. Role of Objective Testing in Assessment

Objective testing is an essential educational method because it provides fast and exact evaluations of broad knowledge. To end unethical exam practices, the Ministry of Education and Training ordered objective testing in the Vietnamese national high school graduating examination system in 2007. By 2025, T/F and SA items will be integrated into the national examination to assess candidate competence (MOET, 2024). Automated systems ensure the objectivity of test scores, promoting fairness in assessments as students develop analytical and problem-solving skills. Historical research shows that exam limitations arise from guesswork and inconsistent evaluation of expressive skills, highlighting the need for various objective question formats.

2.3. Types of Objective Questions

MCQs remain the standard objective testing method (McKenna, 2019) because they effectively measure broad knowledge through structured answer options for decreased guessing opportunities. Since the evaluation method is ineffective at evaluating the ability to apply concepts, it primarily examines knowledge levels and understanding. Research indicates that factual questions linked to hypothetical scenarios produce unreliability alongside substantial guesswork opportunities reaching up to 50% (Burton, 2004). The evaluation method allowed students to produce their answers, improving testing accuracy for their deep understanding and application capabilities. The assessment efficiency of MCQs is limited by their fundamental weakness, which allows students to guess correctly by chance up to 25% using four-option questions. The randomness of guessing can make multiple-choice questions less valid when evaluating sophisticated cognitive abilities such as application and analysis, according to Ali & Ruit (2015).

Different types of assessment questions provide unique advantages and limitations that students need for complete testing of multiple educational objectives. The use of MCQs prevails across Vietnam. However, the development of T/F and SA questions remains limited, especially in Physics education. T/F questions and SA questions help build a complete objective testing framework as supporting elements. The concepts of fundamental principles, including Ohm's Law and current flow directions, can be efficiently assessed through accurate/false items in the subject "Electric Current and Circuits", which reduces students' dependence on

memory recall. Short-answer questions combat the guessing problem completely by requiring students to build their responses, which provides a precise understanding of their capability to evaluate and analyze concepts. Physics education uses SA questions that ask students to calculate or explain circuit behaviour corresponding to Anderson and Krathwohl's (2001) application and analysis of cognitive levels. Burton (2001) states that educators gain flexible assessment capabilities by combining open-response and MCQs. This approach allows them to measure cognitive skills through a wide range of recall and problem-solving while reducing the weaknesses of single formats. Vietnam's T/F and SA question format still needs to focus on a balanced, objective testing design despite not having advanced much compared to MCQs.

2.4. Research Gap

Prior research has validated the design criteria for objective questions and the process of developing an objective question system, which serves as a guide for building throughout the 11th-grade physics course on electric current and circuits. Although the research's physical principles were sound, these investigations fell short of the requirements set forth by the General Education Curriculum for 2018 and the high school graduation test standards for 2025. The educational reform requires competency-based evaluation framework development because MCQ and T/F items must align with national standards while SA questions should be implemented. Standardized evaluation methods are insufficient in Physics education, creating an essential problem because students need to show their knowledge by using Ohm's Law principles in circuit analysis. The new assessment patterns for 2025 need urgent scientific approaches to develop for assessment purposes. The research solves current empirical gaps by creating assessment questions that comply with current educational parameters in Vietnam and modern evaluation performance expectations.

3. METHODOLOGY

3.1. Design-Based Research and Its Application in the Study

The research adopts Design-Based Research (DBR), an educational science method. Because traditional research methods have failed to produce usable solutions for instruction, DBR has emerged to solve this through continuous improvement cycles (Collins, 1992; Barab & Squire, 2016). The new educational process in Vietnam mandates competency-based assessment, and DBR serves as the primary tool for developing testing models that match the 2018 General Education Curriculum requirements. This research adopted the DBR methodology since it helps generate an adaptable MCQ platform that combines performance evaluation options with T/F questions and SA questions for competency assessment needs. The national high school graduation examination 2025 will use various question types to evaluate student cognitive abilities by paying attention to question level and discrimination to provide accurate assessment.

3.2. Process for Developing a Competency-Based Objective Question System

The research methodology uses a five-step structured framework to develop objective questions by educational criteria through question difficulty and discrimination calibration efforts.

 # 1. Defining Assessment Objectives

Setting assessment objectives makes up the first phase of development to link the questions with the 2018 General Education Curriculum and the standardized 2025 high school graduation exam. This question system uses Anderson and Krathwohl's (2001) cognitive taxonomy to assess student thinking at different levels ranging from recall to application. Regarding Grade 11 Physics' "Electric Current and Circuits" topic, the objectives set out a question spectrum that ranges from basic recollection to complex problem-solving exercises and offers a means of differentiating assessments amongst students with different skill levels.

 # 2. Selecting Question Formats for Specific Assessment Objectives

Selecting proper question types commences after defining objectives and aims to maintain an ideal balance between achievement levels and discriminatory capabilities. The combination of various assessment questions improves formal assessment accuracy and response objectivity. Three primary formats are utilized:

- MCQs are adequate for determining memorized material and comprehension. However, their potential for guessing produces inaccurate discrimination unless the questions require proper adjustment.

- The assessment tool of T/F questions serves essential concept evaluations by needing precise item construction for achieving moderate difficulty levels and decreasing random guesses that reach 50% probability as a method for better discrimination of fundamental understanding.

- The assurance of application and analytical assessment is possible through SA questions that request students to write their responses, enhancing discrimination by decreasing random guessing.

Integrating multiple testing items allows the system to create a well-balanced structure that identifies student

abilities covering various cognitive skills.

 # 3. Designing Questions to Scientific Standards

The educational assessment principles guide question development through which questions achieve clear presentation and consistency in student proficiency level. Adjustment to difficulty level maintains the targeted cognitive level (basic recall versus analytical reasoning), and discrimination optimization helps separate high- and low-performing students with valid and reliable parameters.

#4. Testing and Refining the Question System

A group of pilot students will complete the test questions, and their results will be analyzed afterwards to assess difficulty and discrimination levels. This approach ensures clear presentation and alignment with student proficiency, adjusts the difficulty to target cognitive skills (basic recall versus analytical reasoning), and optimizes discrimination to distinguish between high- and low-performing students reliably.

#5. Finalizing and Implementing the Question System

Student performance data guide the standardization process as the question framework transitions to operational use. Evaluating difficulty and discrimination performance enables system improvements, enhancing the framework's ability to meet competency evaluation standards.

3.3. Evaluating Question System Quality

To assess difficulty and discrimination in a question system, we need to evaluate the quality of a system of questions. In tests, the complexity level indicates student competency from basic verbal recall to critical analysis to align with the 2025 competency-based high school graduation test. The system must prove its discriminatory capability to differentiate students with high and low abilities by maintaining accurate competency assessments to prevent fraud.

The study develops an examination-specific question system for the 2025 test through DBR. It offers a repeatable model that balances controlled challenge levels and increases discriminatory power for long-duration education assessment processes.

4. RESULTS

The DBR methodology developed a competency-based objective question system for the "Electric Current and Circuits" assessment in Grade 11 Physics, which received testing along with refinement using 175 students from Hai Ba Trung High School in Hue city in 2025. The educational system used Anderson and Krathwohl's (2001) cognitive taxonomy to fulfill conditions set by the 2025 high school graduation exam (Ministry of Education and Training, 2024). An assessment included 93 items that contained both T/F and SA and MCQs, with 57 MCQs, 12 T/F questions, and 24 SA questions. The assessment method improved the content validity without compromising scientific standards. Descriptive assessment data about difficulty rates was collected in the assessment phase by assessing the percentage of correct answers and discrimination ability, according to Haladyna (2012). The assessment averaged difficulty levels of 0.55, according to Table 1, alongside discrimination scores of 0.45, with each item demonstrating minimum discrimination limits of 0.3 to validate its assessment of multiple cognitive abilities.

Table 1. Difficulty and Discrimination Indices by Cognitive Level.

Cognitive Level	Proportion (%)	Number of Items	Mean Difficulty	Mean Discrimination	Sample Item Example
Knowing	40%	37	0.70	0.40	State Ohm's Law
Understanding	40%	37	0.50	0.45	Calculate resistance in a series circuit
Applying	20%	19	0.25	0.55	Analyze voltage drop in a complex circuit
Overall	100%	93	0.55	0.45	

Questions were distributed across cognitive levels: 40% (37 items) focused on recall and comprehension (e.g., Ohm's Law, electrical power), with a mean difficulty of 0.70 and discrimination of 0.40; 40% (37 items) targeted application (e.g., resistance calculations, Ohm's laws), with a mean difficulty of 0.50 and discrimination of 0.45; and 20% (19 items) emphasized higher-order application (e.g., complex circuit analysis), with a mean difficulty of 0.25 and discrimination of 0.55 (Table 1). The unique item distribution of the test makes it achieve its problem-solving emphasis through managed difficulty levels and discrimination

values aimed at achieving maximum performance differentiation.

To further elucidate the performance of the assessment system, Table 2 presents a detailed analysis of student performance by question type and cognitive level, including the number of items, mean difficulty, mean discrimination, and correct response rates for the 175 students tested.

Table 2. Performance Analysis by Question Type and Cognitive Level.

Question Type	Cognitive Level	Number of Items	Mean Difficulty	Mean Discrimination	Correct Response Rate (%)
MCQs	Knowing	20	0.70	0.40	75%
	Understanding	25	0.60	0.43	60%
	Applying	12	0.50	0.45	45%
T/F	Knowing	8	0.75	0.38	80%
	Understanding	4	0.65	0.40	70%
SA	Understanding	8	0.40	0.48	55%
	Applying	16	0.30	0.52	35%
Overall		93	0.55	0.45	58%

It thus clearly states that the system aligns with the 2025 high school graduation exam requirements as having good cognitive assessment levels from basic recall and application. The MCQs and T/F questions show a higher rate (60-80%) of correct responses for "Knowing" and "Understanding" learning outcome levels, which indicates a strong success in foundational knowledge. On the other hand, the SA questions, especially on "Applying," show a low correct percentage (35%), indicating inadequate skills related to analysis, where also 35% of students scored below 40% on the test. Validity is confirmed by mean difficulty (0.55) and mean discrimination (0.45)-only the lower performance in SA shows the importance of further training in improving competency outcomes in problem-solving and circuit analysis.

Different difficulties and constraints exist despite the framework's favorable design characteristics. The evaluation process based on Haladyna (2012) and three DBR review rounds assisted researchers in generating optimal test questions to reach their desired difficulty levels and discrimination ratings, set with a 0.25 difficulty and a 0.55 discrimination value.

Students succeeded in only 65% of the short-answer tasks, but more than a third earned fewer than 40% correct responses. Further studies need to expand the practical value of this research by adding modification features that match this study to "Electric Current and Circuits" alongside other physics concepts.

5. DISCUSSION

This study's findings provide important insights into the junction of formative assessment and digital transformation in the Grade 11 physics education environment. It is notable that the installation of the digital MCQ practice system resulted in a statistically significant improvement in student performance. This shows that the technology improves formative assessment procedures by giving students an interactive platform to engage with and reinforce their learning of physics ideas. The digital tool's incorporated quick feedback mechanism appears to have contributed to a more responsive learning environment, matching with the principles of successful formative assessment.

The study represents an essential contribution to Vietnam's assessment model regarding its "Electric Current and Circuits" graded questions using competency-based objectives in Grade 11 Physics that align with expectations for the 2025 high school graduation evaluation. This assessment system enables teachers to create evaluations that match exam competencies. It demonstrates an average difficulty level of 0.55 and a discrimination marker of 0.45 while exceeding 90% of the items past the threshold value of 0.3.

This study's research results match those observed in previous studies concerning objective testing approaches. The system applies Haladyna's (2012) method for designing questions by controlling difficulty between 0.25 and 0.85 through tailored discrimination to improve assessment differentiation. According to Burton (2001), teachers should incorporate multiple question styles to check students' advanced academic capabilities, and this method was proven valid through 24 SA questions, achieving a mean difficulty of 0.35 with a discrimination of 0.50, which helped students develop competencies effectively.

Future research should develop the assessment system across different Physics topics by adjusting question difficulty and test discrimination through broader population sampling and various learning environments. Adaptive testing platforms that incorporate technology can simplify test optimization methods while also addressing the issue of scalability. The study provides the research framework for overall estimations and

competence-based evaluation in Vietnam. However, the real advantages depend on several more powerful assessments with practical development and objective testing.

6. CONCLUSION

Through research development, we created a competency-based assessment system for "Electric Current and Circuits" content in Grade 11 Physics that satisfied Vietnam High School Graduation Exam evaluation standards in 2025. The system design research methodology merged 93 evaluation items, which were split between 57 MCQs, 12 T/F, and 24 SA questions for assessing 175 students at Hai Ba Trung High School in Hue city during the 2024–2025 academic year. These testing results displayed a level of difficulty average of 0.55 and a discrimination value of 0.45, which fulfills the specifications of the 2018 General Education Curriculum that focuses on cognitive abilities ranging from basic recall to advanced problem-solving activities (MOET, 2018).

Despite its benefits, the study's focus on a single topic and the observed challenges in short-answer performance (35% of students scoring below 40%) highlight areas for refinement. Researchers must evolve the proposed research framework to examine various Physics subjects and understand how different student groups utilize adaptive learning systems to improve questions. The research has established fundamental principles that can direct the development of competency-based assessment procedures for Vietnam while aiding educational reforms and scientific testing investigations at the national level.

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TÓM TẮT

Chương trình Giáo dục Phổ thông 2018 theo định hướng phát triển. Do đó việc triển khai kì thi tốt nghiệp THPT từ năm 2025 đòi hỏi các phương pháp, công cụ đánh giá phù hợp. Nghiên cứu này nhằm xác định quy trình xây dựng câu hỏi thi môn Vật lý đáp ứng yêu cầu đánh giá năng lực học sinh thông qua phân tích chủ đề "Dòng điện và mạch điện". Nghiên cứu sử dụng phương pháp nghiên cứu dựa trên thiết kế (DBR) để phát triển và thử nghiệm một hệ thống câu hỏi khách quan đa dạng thức, bao gồm câu hỏi trắc nghiệm nhiều lựa chọn, đúng/sai và câu trả lời ngắn, áp dụng cho 175 học sinh lớp 11 tại Trường Trung học Phổ thông Hai Bà Trưng, thành phố Huế trong năm học 2024–2025. Hệ thống đánh giá bao gồm 93 câu hỏi, đo lường năng lực từ mức độ ghi nhớ cơ bản đến phân tích, với độ khó trung bình là 0,55 và độ phân biệt trung bình là 0,45. Dữ liệu đánh giá xác nhận sự phù hợp của công cụ này với định hướng của kì thi tốt nghiệp THPT năm 2025. Tuy nhiên, kết quả cho thấy các câu hỏi chỉ bao quát một lĩnh vực nội dung cụ thể, và hiệu suất không đồng đều của các câu hỏi trả lời ngắn cho thấy nhu cầu cần cải thiện trong tương lai. Các nhà nghiên cứu giáo dục Vật lý có thể sử dụng công cụ này để nâng cao chất lượng đánh giá, hỗ trợ cải cách giáo dục tại Việt Nam và thúc đẩy sự tiến bộ của giáo dục khoa học trong tương lai.