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Theoretical and Practical Foundations for Organizing the Teaching and Learning of Electrical and Radio Measurement Courses in Technical Training Institutions

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A B S T R A C T :

The course "Electrical and Radio Measurement" plays a crucial role in equipping students at technical training institutions with foundational knowledge and practical skills in measurement and instrumentation. However, current teaching practices—often heavily focused on theoretical instruction—have not effectively promoted the development of applied competencies, critical thinking, and active learning. Furthermore, limitations in teaching equipment and the insufficient integration of modern pedagogical approaches pose significant challenges to meeting the evolving demands of technical education.

This study investigates the theoretical and practical foundations for organizing teaching and learning activities in the "Electrical and Radio Measurement" course. It seeks to identify existing shortcomings in course implementation and to propose specific, evidence-based solutions aimed at improving teaching effectiveness and learning outcomes. A mixed-methods approach—incorporating analytical methods, surveys, and statistical analysis—is employed to gather and process feedback from instructors, students, and educational administrators.

The findings are expected to inform curriculum design, encourage active learning, and enhance the integration of theoretical knowledge with practical application. Ultimately, this supports the overarching goal of preparing competent graduates who are capable of thriving in modern engineering and technological environments.

Keywords: Electrical Measurement, Radio Measurement, Technical Education, Active Learning, Curriculum Development, Teaching Effectiveness, Practical Skills, Pedagogical Innovation.

Introduction

In the context of rapid scientific and technological advancement, Electrical Measurement and Radio Electronics (EM&RE) have emerged as foundational disciplines with extensive applications across domains such as telecommunications, automation, industrial control, healthcare, and smart infrastructure. Accordingly, the teaching and learning of EM&RE are becoming increasingly important and are the subject of growing international research interest. Globally, research efforts focus not only on advancing EM&RE technologies—such as 5G, the Internet of Things (IoT), and intelligent measurement systems—but also on innovating instructional methodologies through the use of simulation tools, virtual laboratories, and artificial intelligence to enhance educational outcomes.

In Vietnam, leading technical universities have made notable progress in modernizing curricula and textbooks, investing in laboratory infrastructure, and promoting active learning strategies. Many institutions have established strong links between education, research, and practical applications, thereby enabling students to engage in real-world projects and access modern technological resources. These initiatives have positively contributed to the overall improvement of EM&RE education.

Nevertheless, while general improvements are evident, targeted studies on optimizing the delivery of EM&RE courses—especially in specialized academic environments—remain limited. In some institutions, despite the availability of appropriate equipment and qualified personnel, teaching approaches and student engagement strategies have not yet been fully modernized to align with the requirements of digital transformation and contemporary pedagogy.

Recognizing the importance of EM&RE as a core component of technical education and acknowledging current limitations in instructional practices, this study aims to propose effective solutions for improving the teaching and learning of EM&RE courses. Specifically, it seeks to enhance students' theoretical understanding and practical competencies through curriculum updates, pedagogical innovation, and the integration of modern educational technologies. The outcomes are expected to contribute to the improvement of higher education quality and better prepare graduates to meet the demands of today's technological landscape.

Research Overview

1.1. International Research

Globally, research on the teaching and learning of Electrical Measurement and Radio Electronics is advancing along multiple dimensions, with a dual emphasis on both technological innovations and pedagogical strategies:

Advanced Measurement Technologies: Numerous research initiatives have focused on developing measurement systems leveraging 5G, the Internet of Things (IoT), and automation platforms to enhance the accuracy, responsiveness, and connectivity of EM&RE devices. Concurrently, the integration of artificial intelligence and machine learning into data analysis software enables automatic calibration and optimization of measurement processes, contributing to greater reliability and efficiency.

Modern Teaching Methods: The incorporation of multimedia simulations (e.g., virtual laboratories), immersive environments (e.g., virtual and augmented reality), and interactive online experiments has been shown to significantly improve students' hands-on skills and engagement. Research also highlights the effectiveness of the "learning by doing" approach, which blends theoretical instruction with practical application, in fostering student motivation and improving knowledge retention.

Interdisciplinary Applications: EM&RE technologies now extend well beyond the traditional boundaries of telecommunications and electronics. They are increasingly employed in fields such as healthcare (e.g., diagnostic instruments), industrial automation, environmental monitoring, and smart infrastructure. The integration of real-world case studies into instructional content helps students contextualize theoretical knowledge, enhances their problem-solving skills, and prepares them to address interdisciplinary challenges in professional practice.

1.2. Domestic Research

In Vietnam, leading technical universities have actively developed and modernized training programs and instructional approaches in Electrical Measurement and Radio Electronics. Key areas of progress include:

Curriculum and Textbook Innovation: Institutions such as Hanoi University of Science and Technology, Vietnam National University Ho Chi Minh City, the University of Danang, and the University of Engineering and Technology (VNU Hanoi) have undertaken significant curriculum reforms. These efforts include the development of comprehensive textbooks aligned with international standards, emphasizing a balanced integration of fundamental knowledge and emerging technologies.

Improvement of Teaching Methods: Dedicated EM&RE laboratories have been established and equipped with modern instrumentation. Simulation platforms such as LabVIEW and MATLAB/Simulink, along with virtual laboratory environments, enable students to engage in flexible and autonomous practice, both within and beyond the classroom. Project-based learning (PBL) is increasingly employed to encourage students to explore and address real-world engineering challenges.

Integration of Research and Practice: Numerous university-level, ministerial-level, and international collaborative research initiatives related to EM&RE actively involve both students and faculty members. Partnerships with industry leaders such as Viettel and VNPT provide valuable opportunities for student internships, exposure to cutting-edge technologies, and the implementation of applied measurement projects.

Ongoing Evaluation and Improvement: Continuous assessment of curricula and instructional methods is conducted based on feedback from students, instructors, and labor market stakeholders. Evaluation of graduate outcomes indicates notable improvements in competencies and readiness when active teaching methods and supportive technologies are systematically applied.

2. Theoretical Foundations

2.1. Higher-Education Teaching and Learning Methods

3.1.1. Definition

Higher education teaching and learning methods refer to the wide range of strategies, activities, and interactions between instructors and students that are employed to achieve specific learning outcomes at the university level. Broadly, pedagogical approaches can be classified into two categories:

Traditional Methods: These involve the transmission of knowledge primarily through lectures and passive absorption by students.

Modern (Active) Methods: In contrast, these methods emphasize active student engagement, where learners construct their understanding through interaction, problem-solving, and hands-on experience.

Organizationally, these methods encompass various instructional strategies, including lectures, Socratic dialogue, visual demonstrations, group work, project-based learning, blended learning, and online instruction. Among these, active learning—which incorporates techniques such as collaborative group projects, case-based discussions, and problem-solving scenarios—has been shown to significantly enhance motivation, critical thinking, and long-term retention of knowledge.

3.1.2. EM&RE-Specific Methods

For courses in Electrical and Radio Measurement, the following active learning methods are particularly effective:

Project-Based Learning: Instructors present real-world measurement challenges (e.g., designing a wireless signal acquisition system) and guide student teams through the processes of planning, data collection, and analysis. This approach not only develops technical skills (such as sensor integration and microcontroller programming) but also cultivates transferable skills, including teamwork, time management, and presentation abilities.

Case-Based Instruction: Students analyze authentic or simulated fault scenarios in EM&RE systems (e.g., a calibration error in a spectrum analyzer), identify root causes, and propose corrective actions. This method enhances students' analytical reasoning, problem-solving, and decision-making skills.

Hands-On Laboratory Practice: Well-equipped laboratories allow students to directly interact with measurement hardware (e.g., oscilloscopes, RF signal generators), conduct experiments, and validate theoretical concepts. Continuous feedback from instructors ensures that students apply theory effectively in practical settings.

Simulation-Based Learning: Software tools such as MATLAB/Simulink, Proteus, or specialized virtual laboratory platforms enable students to model signal-processing chains and test configurations in a risk-free environment before actual hardware implementation. This not only reduces setup time but also encourages experimentation and creativity.

By combining these active learning methods, EM&RE instructors can create a dynamic and engaging learning environment that bridges theoretical knowledge with practical application, promotes student autonomy, and aligns with modern engineering education standards.

2.2. Quality and Quality Enhancement in Higher Education

3.2.1. Definitions of Quality

Quality in higher-education teaching and learning may be conceptualized from multiple perspectives:

- Input-based, focusing on faculty qualifications, student preparedness, and infrastructure;
- Output-based, emphasizing graduate competencies and labor-market alignment;
- Value-added, measuring the improvement of student ability during the course;
- Academic value, assessing faculty research productivity;
- Quality culture, which highlights an institutional commitment to continuous pedagogical innovation;
- Accreditation-driven, relying on formal standards and external reviews.

International accreditation bodies recommend evaluating factors such as teaching effectiveness, learner satisfaction, practical application of knowledge, and pedagogical innovation to arrive at a holistic quality assessment.

3.2.2. Quality Enhancement

Enhancing quality in higher education involves an iterative process of curriculum review, pedagogical innovation, and resource allocation. Key components include:

- Curriculum renewal—updating course content to reflect the latest technical advances in EM&RE;
- Faculty development—training instructors in active-learning techniques and emerging measurement technologies;
- Infrastructure investment—ensuring modern laboratories, simulation tools, and software are available;
- Learner support—providing access to online resources, tutoring, and formative feedback;
- Stakeholder feedback—gathering input from students, alumni, and industry partners to guide continuous improvement.

3.2.3. EM&RE Quality Dimensions

In the context of an EM&RE course, quality and its enhancement can be defined as:

- Alignment with learning outcomes—ensuring that teaching methods and assessments directly measure students' ability to perform accurate electrical and radio measurements;
- Resource adequacy—availability of up-to-date sensors, analyzers, and simulation software;
- Instructional competence—instructors' mastery of both theoretical concepts and practical measurement techniques;
- Learning environmentally safe, well-equipped laboratory space and access to virtual-lab platforms;
- Continuous innovation—regular incorporation of new measurement technologies (e.g., IoT-enabled sensors, AI-driven calibration) and teaching practices.

By addressing these dimensions in a coordinated manner, institutions can systematically elevate the quality of EM&RE teaching and learning, thereby better preparing graduates for the demands of modern engineering and technology sectors.

Practical Foundation

4.1. Position and Role of the Electrical Measurement and Radio Electronics Course in the Training Program

The Electrical Measurement and Radio Electronics course is one of the essential foundational courses in the curriculum of undergraduate programs in Electrical and Electronic Engineering. This course plays a crucial role as a bridge between basic theoretical knowledge (such as electrical circuits, basic electronics, and signal theory) and specialized courses in electronics systems, radio frequency, signal transmission, or automated measurement and control.

In terms of content, the course provides students with a theoretical foundation in electrical and radio frequency quantities, while also imparting practical skills in the use of modern measurement instruments, such as oscilloscopes, signal generators, voltmeters, ammeters, and more. The objectives of the course are to help students:

Master common measurement methods in the fields of electricity and radio frequency;

Effectively utilize measurement instruments in both laboratory settings and real-world engineering applications;

Accurately analyze, process, and evaluate measurement data;

Identify and assess the technical parameters of components, electrical circuits, and radio frequency systems.

The EM&RE course not only directly supports the learning of specialized subjects but also contributes to the development of practical technical skills,

analytical thinking, problem-solving capabilities, and technical data processing skills—key competencies in the training of engineers in electrical, electronic, and communication technologies.

4.2. Characteristics of Teaching and Learning in the Electrical Measurement and Radio Electronics Course

4.2.1. Characteristics of the Electrical Measurement and Radio Electronics Course

The Electrical Measurement and Radio Electronics course is part of the foundational knowledge block of the curriculum. It focuses on the principles underlying the use of measuring instruments, measurement methods, and the practical skills needed to operate measurement devices to determine the basic parameters of components in electrical circuits, as well as electrical and radio frequency quantities.

In theory: The theoretical content covers fundamental concepts and principles of measurement, such as accuracy, units of measurement, error analysis, reliability, calibration standards, and measurement methods. Students learn the theoretical foundations of measurement, statistical methods for analyzing measurement data, and the role of standardization in technical measurements.

In practice: Practical sessions help students develop the skills necessary to use measurement instruments, sensors, and other measuring tools. Students are guided in calibrating equipment, performing measurements, recording and analyzing results accurately, and developing the ability to choose appropriate tools and handle experimental data effectively.

Learning Outcomes: Upon completion of the course, students will attain the following competencies in terms of knowledge, skills, and attitudes:

Knowledge: Students will be able to explain the operating principles, technical features, and applications of electrical and radio frequency measurement instruments. They will also be able to describe the principles of measuring electrical quantities (current, voltage, impedance, etc.) and radio frequency quantities (frequency, power, phase, modulation parameters, etc.).

Skills: Students will be able to use measurement equipment safely and correctly. They will be capable of conducting accurate measurements within acceptable error limits. Additionally, they will be able to interpret and convert displayed values from measurement devices into actual measurement results.

Attitudes: Students will demonstrate initiative in learning and self-study to improve their ability to utilize, operate, and enhance measurement equipment in real-world scenarios. They will cultivate scientific and logical thinking for evaluating and analyzing measurement results and solving technical problems.

Overall, the course not only equips students with specialized knowledge and measurement skills but also fosters a positive, proactive learning attitude that aligns with the demands of modern engineering.

4.2.2. Characteristics of Learners

The Electrical Measurement and Radio Electronics course is delivered to a diverse group of students from various technical disciplines, including Electrical Engineering, Electronics, Radio Frequency Engineering, Automation, Information Technology, and other fields at technical training institutions. Each student group has distinct characteristics in terms of prior knowledge, career goals, and practical application needs:

Students majoring in Electrical and Electronic Engineering: For this group, the course provides a solid foundation in electrical measurement methods and instruments, supporting tasks such as inspection, operation, and analysis of electrical circuits and electronic systems.

Students specializing in Radio Frequency and Telecommunications: These learners require a deep understanding of radio measurement techniques—such as power, frequency, attenuation, gain, and frequency response measurement—which are essential for designing, maintaining, and optimizing wireless communication systems.

Students in Automation and Mechatronics: The course introduces students to the use of sensors, data acquisition systems, and signal processing and analysis methods, all of which are critical for developing precise and reliable control systems.

Students in International Joint Programs: This group typically has diverse educational backgrounds. The course equips them with universal technical terminology and specialized language, facilitating effective learning, research, and professional work in international engineering environments.

4.2.3. Characteristics of the Teaching Faculty

The teaching faculty for the Electrical Measurement and Radio Electronics course comprises experts with strong academic backgrounds and extensive teaching experience. Most instructors also possess practical expertise in relevant technical fields and have participated in engineering projects and research collaborations with industry partners, enabling students to access both theoretical knowledge and its real-world applications.

All instructors have received formal pedagogical training and are proficient in the use of modern information technology tools, simulation software, and online teaching platforms. In terms of language proficiency, the faculty demonstrates strong foreign language skills, particularly in the use of technical and professional terminology, which supports both instruction and academic research.

In addition to their teaching responsibilities, faculty members are actively engaged in scientific research and regularly publish in peer-reviewed technical journals. This not only enhances the quality of instruction but also fosters a research-oriented learning environment, encouraging students to participate in scientific inquiry and develop creative problem-solving abilities.

4.2.4. Teaching Infrastructure

The teaching infrastructure for the Electrical Measurement and Radio Electronics course is comprehensively equipped with specialized laboratories, modern measurement instruments, and a collection of digitized learning materials and textbooks. The laboratories feature advanced equipment for measuring electrical and radio-frequency quantities, offering students hands-on experience with a wide range of measurement tools in realistic technical settings.

In addition, significant investment has been made in information technology infrastructure. Simulation software and interactive teaching tools are integrated into the learning process, allowing students to better grasp theoretical concepts and effectively monitor their academic progress.

Digital transformation is a key priority, reflected in the development of a shared digital database for storing and accessing teaching and learning materials. This system facilitates resource sharing between instructors and students, supports self-directed learning, and promotes effective collaboration within an open and flexible learning environment.

4.3. Development of content and teaching methods

4.3.1. Evolution of Teaching Content

Previous Content: The original curriculum primarily focused on fundamental measurement principles, relying heavily on traditional analog instruments such as voltmeters, ammeters, and other conventional devices. The teaching content was predominantly theoretical, with limited opportunities for practical exercises. Instructional materials largely consisted of printed textbooks and conventional handouts.

Current Content: The curriculum has since been revised to include knowledge of advanced measurement technologies and digital instruments. While theoretical instruction still plays a significant role, greater emphasis is now placed on practical application to enhance students' hands-on skills. However, the implementation of laboratory experiments remains limited due to infrastructure constraints. Although teaching materials have been fully digitized, the effectiveness of utilizing these digital resources remains suboptimal, which negatively impacts students' ability to engage in self-study and independent research.

4.3.2. Evolution of Teaching Methods

Previous Methods: The teaching approach was predominantly lecture-based, with instructors delivering content while students passively listened and took notes. Opportunities for student engagement through discussion or hands-on activities were limited. Assessment methods focused mainly on written tests and essay-based examinations.

Current Methods: Active teaching methodologies have been increasingly adopted. Instructors now encourage student participation through group activities, discussions, and practical exercises. Information technology and instructional software are integrated into lessons to enhance engagement and learning effectiveness. Assessment practices have also evolved to become more comprehensive, incorporating not only periodic testing but also evaluations of students' learning attitudes and participation in practical work. At the end of the course, students undertake a practical examination that holistically assesses their knowledge, skills, and attitudes.

4.4. Current Situation of Teaching and Learning Quality in the Electrical Measurement and Radio Electronics course

4.4.1. Current Status

a) Status of Educational Management

The quality of educational management at the Academy has seen notable improvements, including the implementation of a centralized administrative system and compliance with state regulations. However, several challenges persist—most notably, inadequate infrastructure, a shortage of laboratory equipment, and limited development of modern training modalities. Although the curriculum has been revised, it still lacks timely updates incorporating cutting-edge technological advancements. Additionally, investments in teaching support tools remain insufficient.

b) Status of Teaching Staff Quality

The current teaching staff is diverse in qualifications and experience. Nevertheless, there is a shortage of senior lecturers, and a lack of continuous professional development in modern knowledge and pedagogical methods. The application of educational technologies remains limited and, in many cases, ineffective. This hampers teaching quality and reduces the level of interaction between instructors and students.

Table 1. Assessment of Teaching Staff Quality Based on Evaluation Criteria

Evaluation Criteria	Current Situation and Limitations
Academic Qualification	The proportion of lecturers holding advanced degrees does not yet meet the demands for improving training quality. The update of knowledge in the field of EM&RE remains inconsistent.
Teaching Methodology	There is a lack of flexibility in applying active teaching methods and educational technology tools.
Foreign Language Proficiency	Limited ability to access and study international literature and update new technologies.
ICT Competency	Ineffective application of information and communication technologies (ICT) in teaching and scientific research.
Practical Experience	Insufficient practical experience and lack of up-to-date industry exposure.
Professional and Technical Titles	A shortage of senior lecturers to provide in-depth academic and technical guidance.

c) Current Status of Learners' Quality

Although learners generally have a solid foundation in terms of health and basic knowledge, they lack practical experience and political maturity, which limits their ability to absorb knowledge and develop hands-on skills. The declining trend in entry-level quality affects learners' capacity to study and acquire knowledge, especially in fields requiring in-depth expertise.

d) Current Status of Course Content Quality

The content of the Electrical Measurement and Radio Electronics course remains outdated and misaligned with modern technological advancements. Teaching materials need to be improved to ensure accuracy and practical relevance. The current time allocation for the course is not optimal, negatively impacting students' ability to absorb and deeply understand the subject matter.

e) Current Status of the Application of Active Teaching Methods

Although EM&RE is an experimental science, active teaching methods have not been fully utilized. Some instructors lack modern teaching skills and methodologies, resulting in primarily lecture-based instruction. This reduces learners' capacity for creative thinking and independent learning.

g) Current Status of Assessment and Evaluation Quality

The current assessment system mainly relies on midterm and final exams, lacking diversity and failing to adequately reflect practical skills. It is essential to publicize evaluation criteria and apply more varied assessment methods to enhance objectivity and effectiveness in evaluating learning outcomes.

4.4.2. Survey on Teaching and Learning Quality Assessment

To assess the current state of teaching and learning in the Electrical Measurement and Radio Electronics course, the research team conducted a survey targeting both lecturers and students. The survey aimed to gather comprehensive feedback on key aspects of the training program, including course importance, content relevance, teaching quality, instructional methods, assessment practices, and laboratory infrastructure.

a) Survey Methodology

Participants: Lecturers and students directly involved in the EM&RE course.

Format: Questionnaires distributed in both online and paper-based formats.

Content: Questions focused on the effectiveness of teaching, the adequacy of learning materials, the appropriateness of teaching and assessment methods, and the condition of laboratory facilities.

b) Key Findings

The course is widely recognized as essential within the technical curriculum. However, its content requires revisions to better reflect real-world applications and eliminate overly theoretical or redundant material.

Learning materials and laboratory resources are outdated and in need of modernization to effectively support both teaching and hands-on learning.

While current teaching and assessment methods are generally viewed as acceptable, there is a need for increased interaction between lecturers and students, as well as more varied and practical forms of evaluation.

Lecturers received high ratings for their subject matter expertise and sense of responsibility. Nevertheless, additional professional development is needed, particularly in the areas of educational technology integration and the design of practice-oriented exercises.

The survey results reaffirm the critical role of the EM&RE course in technical education and underscore several areas for improvement: updating and realigning the curriculum with industry standards, modernizing laboratory equipment, digitizing learning resources, and diversifying teaching and evaluation strategies. These enhancements are essential for improving instructional effectiveness and fostering deeper student engagement and understanding.

3. Conclusion

This paper aims to clarify the theoretical and practical foundations for organizing the teaching and learning of the Electrical Measurement and Radio Electronics course at technical training institutions.

- Based on an analysis of the current situation, several key limitations have been identified:

Students often exhibit low awareness, limited motivation, and a passive learning attitude.

Some lecturers demonstrate limited teaching capacity and insufficient efforts to update their subject knowledge.

Curriculum and pedagogical reforms are progressing slowly, with limited integration of information technology and simulation-based tools.

Teaching infrastructure—particularly laboratory equipment—is outdated and poorly managed.

These challenges significantly affect the overall quality of teaching and learning, highlighting the urgent need for improvements across multiple dimensions, including learner engagement, instructor capability, institutional management, and infrastructure development.

- To address these issues, the study proposes four strategic solution groups:

Student Motivation and Responsibility – Promoting a sense of responsibility and encouraging active, self-directed learning.

Lecturer Development – Enhancing teaching competence through continuous professional development and industry engagement.

Pedagogical Reform – Updating course content, restructuring delivery methods, and integrating modern educational technologies.

Infrastructure Investment and Management – Improving laboratory conditions and reforming infrastructure management to support more effective teaching and practice.

- Future Research Directions

To support the continuous improvement of EM&RE instruction, further studies should explore:

The application of blended learning models and flipped classrooms tailored to EM&RE.

The design and deployment of digital learning resources and online platforms to facilitate self-learning and virtual practice environments.

The development of outcome-based assessment tools, incorporating simulation technologies to measure both theoretical knowledge and practical competencies.

Surveys and case studies on learner-centered teaching models suited to the specific characteristics of technical training institutions.

These research efforts will contribute to the advancement of theoretical and practical frameworks for teaching EM&RE, ultimately enhancing the quality of technical workforce training in alignment with higher education reforms and the demands of technological innovation.

REFERENCES

1. Chaijum, N., & Hiranyachattada, T. (2020). Integrated Learning and Project-Based Learning for Project of Electrical Measurement and Instrumentations in Electrical Engineering Course. European Journal of Science and Mathematics Education, 8(1), 6–11.
2. Santhosh, K. V., & Rao, K. G. (Eds.). (2021). Smart Sensors Measurements and Instrumentation: Select Proceedings of CISCON 2020. Lecture Notes in Electrical Engineering, 750. Springer.
3. Zulnaidi, H., et al. (2020). Readiness and Understanding of Technical Vocational Education and Training (TVET) Curriculum towards Industrial Revolution 4.0. International Journal of Innovation, Creativity and Change, 10(10), 1–13.
4. UNESCO-UNEVOC. (2020). Innovating Technical and Vocational Education and Training: A Framework for Institutions. UNESCO Publishing.
5. Wang, L., & Zhang, Y. (2020). Electrical Control Technology and PLC Course Teaching Reform and Practice. Procedia Computer Science, 166, 217–220.
6. Ogbuanya, T. C., & Okeke, B. C. (2022). Electrical Measurement and Control Skills for Manpower Development in Nigeria. International Journal of Engineering and Advanced Technology Studies, 10(2), 16–32.
7. Kumar, R., & Sharma, S. (2020). Interconnecting Teaching and Learning, Assessment, Measurement and Evaluation. Journal of Emerging Technologies and Innovative Research, 7(2), 269–273.
8. Goyal, S., & Singh, R. (2022). Enhancing Practical Learning in the Electrical Workshop Using Augmented Reality. International Journal of Research in Engineering and Science, 11(9), 343–347.
9. Springer, M. (2023). Rasch Measurement in Discipline-Based Physics Education Research. In Advances in Physics Education Research (pp. 25–45). Springer.
10. CTE Research Network. (2020). Improving Measurement in Career and Technical Education to Support Rigorous Research. CTE Research Network Reports.