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AI-Assisted Instructional Reform in Electrical and Electronic Skills Training for ASEAN International Students

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Abstract: *In electrical and electronic skills training for ASEAN international students, instructional efficacy is often impeded by language barriers, scarce multilingual resources, and insufficient formative assessment. Addressing these challenges, this study develops an AI enabled pedagogical model structured around the experiential learning cycle. The proposed architecture unites preparatory inquiry, in class scaffolding, and post class practice into a closed loop learning continuum. Relying on a domain specific multilingual corpus and an intelligent conversational agent, the system provides contextualized scaffolding for theoretical modeling and practical circuit debugging. In parallel, an AI driven evaluation mechanism captures both formative engagement logs and final operational outcomes. Empirical trials and questionnaire findings reveal marked improvements in student practical competencies alongside positive user reception, offering adaptable paradigms for cross border engineering curriculum reform.*

Keywords: *Electrical and electronic skills training, Multilingual corpus, ASEAN international students, AI assisted instruction*

1. Introduction

Educational digitization and internationalization collectively impose new imperatives on higher engineering pedagogy [1]. Amid deepening China ASEAN educational cooperation, digital transformation provides strategic momentum for regional collaboration [2]. Tailoring engineering curricula for ASEAN international students demands aligning diverse linguistic profiles with technical competencies through intelligent technological scaffolding. Concurrently, artificial intelligence advancements in conversational interaction, reasoning, and adaptive feedback present viable paths to enrich instructional delivery [3-5]. The central challenge for undergraduate institutions lies in embedding multilingual technical resources into authentic laboratory environments. Synthesizing resource distribution, practical mentoring, and continuous formative assessment remains vital to sustainable curriculum innovation.

"Electrical and Electronic Skills Training" is a highly comprehensive course grounded in the theoretical foundations of circuits and electronic technology. Beyond schematic interpretation and circuit analysis, the curriculum requires practical student competence to translate abstract concepts into physical operations. Prior research has actively explored digital instruction, formative assessment, and AI-agent-supported autonomous learning in electrical engineering experiments [6-7]. These efforts provide valuable references for curriculum reform. However, instruction tailored to ASEAN international students remains impeded by dense technical terminology, a scarcity of multilingual resources, and insufficient procedural feedback. Such challenges prevent learners from advancing from mechanical imitation to independent practice. Therefore, leveraging AI technology to eliminate cross lingual barriers and integrate theoretical comprehension with practical training has become a crucial priority for higher engineering education.

2. Analysis of the Current Teaching Status of "Electrical and Electronic Skills Training"

The "Electrical and Electronic Skills Training" course serves as a core practical curriculum for electronic information engineering majors, integrating component inspection, instrumentation, manual soldering, and circuit debugging into experiential practice. In cross border instruction for ASEAN learners, significant disparities in linguistic proficiency, prior technical background, and practical

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competence hinder knowledge comprehension, hands on mastery, and pedagogical interaction. Major challenges confronting this instructional context include the following dimensions.

2.1. Scarcity of Multilingual Professional Resources and Low Content-Language Adaptability

The Chinese proficiency of ASEAN international students is insufficient to support accurate understanding of professional terminology and experimental principles, while existing textbooks and guides are predominantly in Chinese, lacking a systematic set of supporting resources in multiple languages. At the same time, clear cross-language mappings between terminology, legends, and operational steps have not yet been established, and the review and update mechanisms for multilingual materials are lagging behind, making it difficult to ensure consistency in professional expression. This compounded linguistic and disciplinary barrier compels learners to devote excessive cognitive resources to real time translation, thereby substantially elevating cognitive load and obstructing the systematic acquisition of core engineering knowledge.

2.2. Limited Faculty Cross-Linguistic Competence and Impeded In-Depth Professional Interaction

Effective instruction in "Electrical and Electronic Skills Training" requires precise transmission of intricate technical details. Because most instructors rely on English as an instructional medium without proficiency in native ASEAN languages, mutual linguistic limitations cause substantial information attenuation during parameter analysis, anomaly description, and circuit troubleshooting. Physical demonstrations convey procedural execution yet fail to clarify underlying engineering logic across language barriers. Furthermore, constrained student expression impedes technical inquiry and iterative clarification, severely restricting the depth of two way professional dialogue.

2.3. Monotonous Practical Training Approaches and Unmet Differentiated Learning Needs

Conventional practical instruction relies predominantly on a standardized sequence of lecture delivery, physical demonstration, student execution, and report submission, which fails to accommodate diverse linguistic and technical proficiencies among international learners. Constrained laboratory schedules prevent instructors from providing personalized guidance while maintaining uniform curricular progress. Consequently, many students resort to mechanical imitation, completing operational steps without internalizing core circuit principles and diagnostic troubleshooting logic. When task parameters vary, learners exhibit limited methodological transfer, exposing an acute shortage of tiered task design, guided inquiry, and individualized scaffolding.

2.4. Operational Outcome-Biased Assessment and Inadequate Process Diagnosis and Feedback

Existing course evaluation depends excessively on procedural completion, laboratory reports, and summative exams, overlooking real time comprehension of specialized terminology, operational decision making, and fault diagnosis. Student errors frequently stem from intertwined linguistic hurdles, conceptual misunderstandings, and procedural inexperience, rendering isolated summative metrics inadequate for root cause attribution. Furthermore, the lack of continuous process data decouples laboratory error correction from subsequent tutoring. Consequently, a closed loop evaluation system integrating diagnostic detection, targeted intervention, and continuous verification remains undeveloped.

3. AI-Driven Practical Teaching Reform of Electronics for ASEAN Students

3.1. Constructing a Multilingual Intelligent Corpus

To address key bottlenecks in the "Electrical and Electronic Skills Training" course, including the shortage of multilingual resources, inconsistent terminology, and fragmented materials, this study develops an AI-powered intelligent corpus. Anchored in Chinese, English, and Thai with extensible compatibility for broader ASEAN languages, the corpus systematically incorporates instructional modules, operational procedures, and authentic engineering scenarios to underpin curriculum reform. Given the scarcity of cross lingual parallel corpora and the specialized nature of electrical terminology, the construction framework proceeds across four sequential phases: preparation, annotation, analysis, and application. Figure 1 illustrates the overall workflow.

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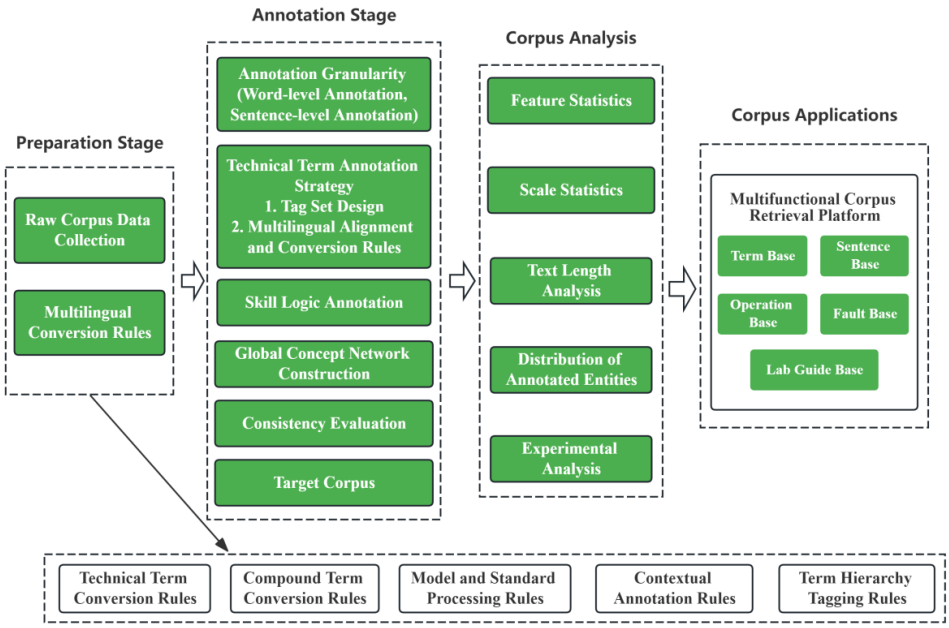


Figure 1: Flowchart of AI Intelligent Corpus Construction.

3.1.1. Corpus collection and standardized processing

This study systematically constructed a diverse textual corpus centered on eight core practical projects in electronic information engineering. The dataset integrates laboratory manuals, component data sheets, standard operating procedures, circuit schematics, and safety protocols. Specialized text processing tools, including EmEditor, facilitate systematic cleaning, duplicate removal, and format standardization. Furthermore, a structured multilingual conversion framework governs technical terminology translation, contextual annotation, and hierarchical labeling. These procedures yield a standardized foundational corpus, establishing a dependable benchmark for downstream annotation and multilingual alignment.

3.1.2. Multi-granularity annotation and precise alignment across multiple languages

Operating on word and sentence levels, this study applies a dual granularity strategy for terminology labeling, integrating domain specific tag sets with cross lingual conversion rules. Automated segmentation in the YiCorpus platform accelerates technical term extraction, grammatical tagging, and knowledge indexing. Meanwhile, procedural logic annotation and domain graph modeling advance alongside semantic evaluations. Multidirectional alignment across Chinese, English, and Thai texts using the SISU Aligner tool generates a standardized multilingual corpus tailored for ASEAN engineering learners.

3.1.3. Systematic analysis and quality verification of the corpus

To systematically evaluate corpus coverage, balance, and completeness, we perform quantitative statistical evaluations across multiple dimensions. These analytical dimensions encompass corpus typology, overall scale, document length distributions, and annotated entity distributions. In parallel, empirical instructional trials are conducted within authentic teaching scenarios to test corpus adaptability and practical utility during cross-border practical training. Such empirical findings provide direct data-driven guidance for iterative refinement. Ultimately, these procedures ensure the scientific rigor, pedagogical usability, and long-term scalability of the corpus architecture.

3.1.4. Construction of intelligent corpus and its application in teaching

Following empirical validation, the standardized corpus is archived into a centralized database. The developed retrieval platform integrates five functional modules: terminology, sentence examples, operational procedures, fault diagnosis, and experimental guidance. Supporting multilingual keyword querying, semantic retrieval, and associative searching, the system ensures seamless resource maintenance and pedagogical reuse. Consequently, ASEAN international students access and compare multilingual materials on demand. This infrastructure resolves persistent cross border instructional bottlenecks regarding resource scarcity, retrieval inefficiencies, and linguistic barriers, providing robust scaffolding for electronic information practical training.

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3.2. Integrating an AI-Powered Multilingual Intelligent Teaching Assistant

With intelligent agents as the core, we develop an AI-powered multilingual intelligent teaching assistant capable of dialogue, question answering, instructional guidance, and fault diagnosis. As illustrated in Figure 2, this assistant covers the entire closed loop spanning teaching, practical training, diagnosis, and improvement. It directly addresses key issues such as insufficient personalized guidance, the lack of real-time support, and delayed diagnosis.

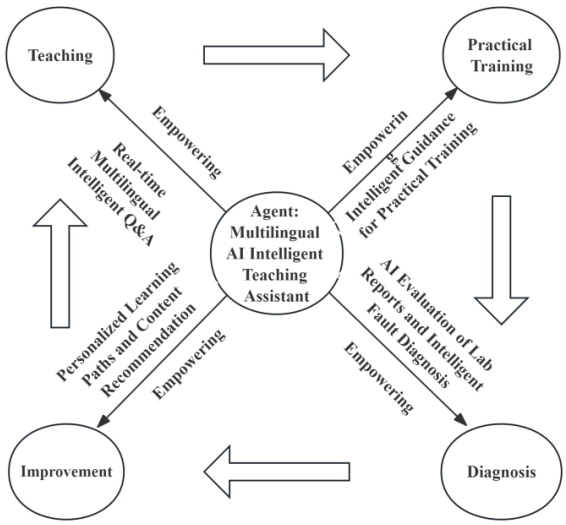


Figure 2: Multilingual AI Intelligent Teaching Assistant.

3.2.1. Multi-language real-time intelligent answering

Accommodating multilingual inputs across Chinese, English, and Thai, the assistant accurately resolves student queries regarding terminology, operational doubts, and circuit anomalies. Providing accessible explanations, the system fosters on demand support, cross language comparison, and autonomous troubleshooting, enabling learners to swiftly overcome cognitive barriers during practical training.

3.2.2. Intelligent guidance during the training process

Across core practical modules spanning component inspection, instrumentation, manual soldering, schematic analysis, and microcontroller debugging, the assistant provides real time procedural guidance, safety warnings, and proactive fault alerts. Such structured interventions guide international students through independent practical operations, thereby reducing reliance on direct physical supervision while fostering autonomous engineering competence.

3.2.3. AI review of experimental reports and intelligent fault diagnosis

The intelligent agent automatically parses experimental procedures, operational logic, data records, and diagnostic analyses to generate formative evaluations of laboratory rep. It identifies procedural discrepancies and provides targeted guidance for refinement. Simultaneously, based on symptom descriptions and operation logs, the system infers underlying root causes and recommends structured troubleshooting strategies, markedly improving practical training efficiency.

3.2.4. Personalized learning path and content push

On the basis of behavioral learning data, the agent dynamically identifies individual knowledge gaps, error-prone operations, and terminology deficiencies among international students. It subsequently delivers tailored terminology glossaries, demonstration videos, exemplary benchmark cases, and targeted exercises. This continuous instructional loop delivers individualized tutoring and dynamic reinforcement across the entire practical training process.

3.3. Closed Loop Instructional Architecture Across Three Learning Stages

Through a multilingual corpus and an AI-powered teaching assistant, this study integrates Kolb's experiential learning cycle into the "Electrical and Electronic Skills Training" course. As depicted in

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Figure 3, a seamless instructional framework bridges pre-class inquiry, in-class scaffolding, and post-class reinforcement. Guided by authentic engineering tasks, students progress through concrete experience, reflective observation, conceptual modeling, and experimental verification. This closed-loop process effectively transforms procedural operational experience into profound engineering comprehension and practical competence.

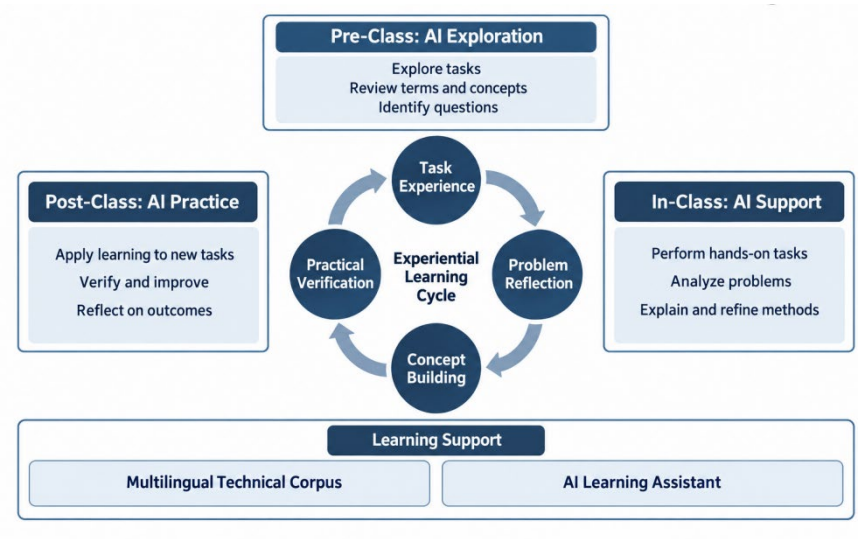


Figure 3: AI-Enhanced Electrical and Electronic Skills Training.

3.3.1. AI-Enabled Pre-Class Inquiry: Task Orientation and Initial Reflection

Across foundational modules encompassing component testing, instrument calibration, manual soldering, and printed circuit board assembly, instructors design structured inquiry activities. Accompanying digital assets, including physical photographs, demonstration videos, and fault scenarios, help students establish a concrete conceptual baseline. Learners employ the AI teaching assistant for cross-lingual terminology contrast, knowledge querying, and rapid self-testing. Any persistent conceptual gaps and procedural queries are documented into a structured pre-class inquiry dossier. Based on student diagnostic feedback, instructors dynamically adjust classroom instructional priorities and deploy differentiated tasks. Consequently, preparatory inquiry serves as an essential diagnostic foundation for practical laboratory experimentation.

3.3.2. AI-Scaffolded In-Class Learning: Practical Exploration and Conceptual Construction

Following foundational safety briefings and procedural demonstrations, students conduct stratified practical training, documenting operational phenomena and measurement outcomes against pre class predictions. Encountering deviations, learners leverage AI multilingual explanations and heuristic prompts to retrace procedural steps, formulate hypotheses, and validate reasoning through peer discussions and hardware tests. Instructors address systemic errors on site, guiding students to connect observable phenomena, influencing factors, and underlying technical principles. Learners subsequently refine operational parameters and revalidate outcomes, establishing rigorous troubleshooting strategies that bridge empirical intuition and theoretical comprehension.

3.3.3. AI-Assisted Post-Class Practice: Knowledge Transfer and Reflection

Drawing on classroom evaluations, instructors deploy targeted reinforcement tasks to resolve specific learning deficits. Students investigate methodological transfer across diverse circuit parameters and fault scenarios, combining AI guidance with physical testing in open laboratory sessions. Progressive withdrawal of instructional scaffolding requires learners to justify operational decisions and synthesize comprehensive diagnostic documentation covering fault symptoms, theoretical rationales, and verification procedures. Instructors appraise competency mastery through reflective logs, channeling persistent challenges into subsequent lessons to complete an iterative improvement loop.

Across this three stage instructional continuum, intelligent scaffolding seamlessly bridges preparatory inquiry, classroom construction, and post laboratory verification. While instructors coordinate pedagogical design, synchronous guidance, and authentic evaluation, students steadily cultivate autonomous learning habits and practical problem solving capabilities through sustained experimentation and reflection.

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3.4. Developing an AI-Driven Diversified Assessment Frameworks

In instructional assessment, an AI driven multidimensional framework unifies formative, summative, and developmental evaluations, as detailed in Table 1. The grading matrix distributes sixty percent to formative assessment and forty percent to summative assessment. Formative evaluation systematically tracks learning engagement, practical performance, and technical competencies across progressive components, including pre-class preparation, AI assistant interaction, practical tasks, AI reviewed experiment reports, classroom practice, and group collaboration. Summative evaluation assesses independent student proficiency in component testing, instrumentation, manual soldering, and circuit debugging through comprehensive practical examinations. Instructors calibrate AI generated scores against physical performance to guide targeted remedial instruction.

Table 1: Design of AI-driven diversified evaluation system.

<table>
<tr><th></th><th colspan="2">Formative Assessment (Regular 60%)</th><th>Summative Assessment (Final 40%)</th></tr>
<tr><td rowspan="5">Comprehensive Evaluation</td><td colspan="2">Pre-class Preparation Quality 12%</td><td rowspan="5">Course Practical Assessment 40%</td></tr>
<tr><td rowspan="3">AI Evaluation</td><td>AI Assistant Supported Learning Status 12%</td></tr>
<tr><td>AI Practical Tasks 12%</td></tr>
<tr><td>AI Reviewed Experiment Reports 8%</td></tr>
<tr><td colspan="2">Classroom Practice 12%</td></tr>
<tr><td>Value-added Evaluation</td><td colspan="3">Participating in teachers' scientific research activities, actively joining academic competitions, implementing project assessments (project grading and report writing), etc.</td></tr>
</table>

The value added evaluation protocol recognizes student participation in scientific research and discipline competitions by awarding incremental bonus points according to substantive project involvement and verified distinctions. Under this framework, applying for an invention patent or software copyright earns a 10 point bonus. Competitive achievements grant 10 points for national awards, 5 points for provincial or ministerial honors, and 3 points for university level accolades. Consequently, this tiered incentive scheme encourages continuous self directed innovation alongside coursework.

For final course evaluation, an AI assisted project evaluation mechanism is introduced to appraise summative design deliverables. Table 2 outlines the specific evaluation criteria, detailing grading dimensions, assessment indicators, and scoring weights.

Table 2: Assessment Criteria.

Evaluation Items	Points	Scoring reference criteria					Score
		Excellent	Good	Fair	Pass	Fail	
Study attitude and timely submission	10	9	8	7	6	Below 6	
Team collaboration	15	13.5	12	10.5	9	Below 9	
Degree of completion	20	18	16	14	12	Below 12	
Quality of completion	20	18	16	14	12	Below 12	
Resolving unexpected issues	20	18	16	14	12	Below 12	
Experience summary	15	13.5	12	10.5	9	Below 9	

4. AI-Driven Practical Teaching Reform of Electronics for ASEAN Students

4.1. Construction and Deployment of the Multilingual Engineering Corpus

The multilingual professional corpus for the "Electrical and Electronic Skills Training" course is developed through the YiCorpus platform, encompassing core laboratory modules including component testing, instrumentation, manual soldering, schematic reading, and microcontroller system debugging. The repository integrates professional terminology, experimental principles, operational instructions, safety precautions, and typical fault cases. Through terminology alignment and content correlation, fragmented instructional materials are systematically converted into searchable and reusable curriculum assets. This provides multilingual support to facilitate international students in mastering professional knowledge and operational requirements, while establishing an authoritative knowledge base for the AI learning assistant to conduct course related question answering.

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4.2. Implementation of an Intelligent Assistant Across Practical Workflows

Anchored in the multilingual professional corpus, an AI learning assistant tailored for coursework and hands on training challenges is established to deliver specialized terminology explanations, project question answering, procedural logic prompts, and fault analysis support. Students can articulate learning difficulties in their native languages, while continuous follow up queries help clarify concepts, unpack operational rationale, and streamline troubleshooting pathways. The assistant seamlessly unifies pre class inquiry, in class scaffolding, and post class practice, delivering interactive learning support for autonomous students alongside practical analytical insights for instructors providing cross lingual instruction. Anchored in AI assisted training tasks on the Xuexitong learning platform alongside automated laboratory report evaluations, this mechanism establishes a coherent instructional loop spanning task distribution, work submission, real time feedback, and iterative revision.

4.3. Significant improvement in students' academic performance

To investigate the teaching efficiency of the AI-empowered teaching reform in the "Electrical and Electronic Skill Training" course for ASEAN international students, the Grade 2024 Artificial Intelligence ASEAN class was selected as the experimental class, while the Grade 2024 Software Engineering international class continued to adopt the traditional teaching model. Following one academic year of implementation, target attainment distributions for both cohorts appear in Figure 4.

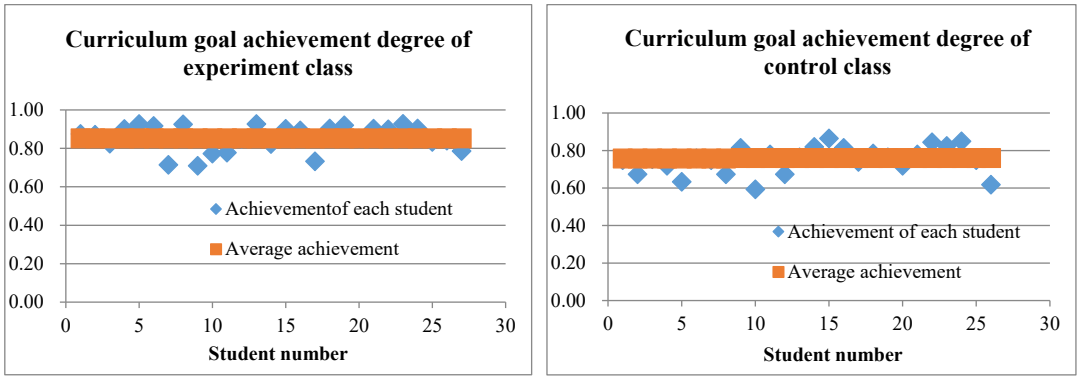


Figure 4: Comparison chart of course goal achievement.

As shown in the figures, the average achievement level of the experimental class has significantly improved compared to that of the control class, and the distribution of student achievement is more concentrated. Compared with the traditional teaching model, the AI-empowered teaching approach for the "Electrical and Electronic Skill Training" course yields more significant learning outcomes. Through synergistic support from the multilingual corpus and the AI teaching assistant, linguistic scaffolding, operational mentoring, and formative feedback are seamlessly embedded across the entire learning process. This provides comprehensive support for students to understand professional knowledge, conduct independent exploration, and improve practical operations.

4.4. Results of the Questionnaire Survey

Survey metrics illustrated across Figure 5 capture student evaluations across four pedagogical dimensions. Multilingual terminological assistance in Figure 5a received 89.09 percent positive appraisal, comprising 25.45 percent very helpful and 63.64 percent helpful ratings. Technical explanation accuracy in Figure 5b achieved an identical approval rate of 89.09 percent, with 27.27 percent highly satisfied and 61.82 percent satisfied respondents. Guidance for practical troubleshooting in Figure 5c secured 87.27 percent overall endorsement, while peer recommendation willingness in Figure 5d peaked at 90.91 percent. These empirical distributions substantiate widespread learner endorsement and validate the pedagogical efficacy of the reformed instructional model.

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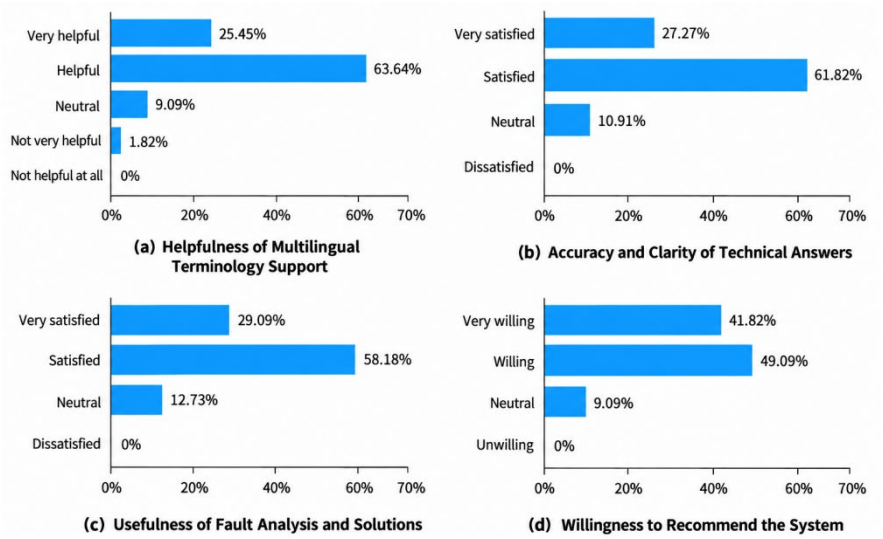


Figure 5: Results of the Questionnaire Survey.

5. Conclusions

The "Electrical and Electronic Skills Training" course serves as a foundational pillar for cultivating engineering competencies among ASEAN international students. Integrating a specialized multilingual corpus with an intelligent AI assistant, this study realizes a cohesive instructional model bridging preparatory inquiry, real time laboratory scaffolding, and autonomous practice. Furthermore, an innovative multidimensional evaluation matrix aligns formative diagnostic tracking with summative examination. Empirical outcomes demonstrate substantial gains in conceptual comprehension, procedural proficiency, and learner satisfaction. Consequently, this framework provides viable pedagogical paradigms for internationalized engineering education across higher institutions.

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