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Xalqaro miqyosidagi ilmiy-texnik anjuman materiallarida zamonaviy kompyuter ilmlari va muhandislik texnologiyalari sohasidagi innovatsion tadqiqotlar aks etgan.

Globallashuv sharoitida davlatimizni yanada barqaror va jadal sur’atlar bilan rivojlantirish bo‘yicha amalga oshirilayotgan islohotlar samarasini yaxshilash sohasidagi ilmiy-tadqiqot ishlariga alohida e’tibor qaratilgan. Zero iqtisodiyotning, ijtimoiy sohalarni qamrab olgan modernizatsiya jarayonlari, hayotning barcha sohalarini liberallashtirishni talab qilmoqda.

Ushbu ilmiy ma’ruza tezislari to‘plamida mamlakatimiz va xorijlik turli yo‘nalishlarda faoliyat olib borayotgan mutaxassislar, olimlar, professor-o‘qituvchilar, ilmiy tadqiqot institutlari va markazlarining ilmiy xodimlari, tadqiqotchilari, magistr va talabalarning ilmiy-tadqiqot ishlari natijalari mujassamlashgan.

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Mazkur to‘plamga kiritilgan ma’ruza tezislarining mazmuni, undagi statistik ma’lumotlar va me’yoriy hujjatlarning to‘g‘riligi hamda tanqidiy fikr-mulohazalar, keltirilgan takliflarga mualliflarning o‘zlari mas’uldirlar.

DESIGNING ADAPTIVE DIGITAL LEARNING PATHWAYS TO STRENGTHEN THE PROFESSIONAL READINESS OF FUTURE ELECTRICAL ENGINEERS

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Abstract. This paper examines an adaptive approach to organizing digital learning in electrical engineering education. It explains how initial diagnosis, differentiated electronic resources, professionally oriented tasks, and formative feedback can be combined into a coherent learning pathway. Particular attention is paid to the courses Electric Machines and related technical subjects, in which students must connect theoretical concepts with equipment selection, calculation, and operating decisions. A staged instructional model and an evidence-based assessment matrix are proposed. The discussion presents a methodological framework rather than results from a separately conducted experiment.

Keywords: adaptive learning, engineering education, digital learning pathway, electrical engineering, professional competence, formative assessment, electronic learning resources, independent study.

INTRODUCTION

The modernization of engineering education has made the relationship between theoretical knowledge and practical decision-making particularly important. An electrical engineering graduate is expected not merely to recall formulas, but to interpret equipment characteristics, select safe operating conditions, estimate losses, and defend an engineering recommendation. These abilities depend on how students work with concepts over time. A single sequence of lectures and identical assignments cannot always address differences in prerequisite knowledge, pace of understanding, and practical experience. Digital learning environments offer opportunities to respond to such differences without separating professional standards for students. Adaptive learning, as discussed here, does not mean leaving each student alone with an automated platform. It means designing a structured set of alternative routes toward the same competence outcomes. The instructor defines what must be mastered; diagnostic evidence helps determine the initial route; tasks become progressively more demanding; and feedback prompts the learner to revisit weak concepts. Such an approach is especially relevant to electrical machines, where difficulties in understanding magnetic fields, torque, efficiency, or load characteristics can later appear as mistakes in calculations and equipment choices. A targeted digital pathway can connect missing foundational knowledge with the next meaningful professional task.

THE DIDACTIC LOGIC OF AN ADAPTIVE PATHWAY

The core of an adaptive pathway consists of four interconnected elements: a common competence target, a diagnostic entry point, a choice of learning activities,

and evidence of achievement. A competence target should describe an observable performance rather than the amount of content consumed. For instance, instead of requiring students simply to study induction motors, a teacher may require them to compare two motors for a specified industrial load, justify their selection, and identify operational constraints. This target can be reached through different resource combinations, yet the assessment standard remains shared. Entry diagnosis should distinguish between conceptual uncertainty and procedural difficulty. A student may correctly identify the parts of a transformer yet be unable to explain why the secondary voltage changes with the turns ratio. Another may understand the principle but make errors in unit conversion or graphical interpretation. Short concept questions, calculation items, and explanation prompts make these differences visible. Their purpose is instructional: the outcome should direct a learner toward an appropriate task, not permanently label the learner as weak or strong. After a short cycle, the pathway should be adjusted in response to new work. In an electronic course, pathways can be organized as a foundation route, an application route, and an extension route. The foundation route revisits essential ideas using concise explanations, circuit diagrams, worked examples, and self-check questions. The application route requires the learner to solve standard professional problems, interpret machine characteristics, and explain decisions. The extension route introduces ambiguity, competing technical criteria, or a comparison of operating strategies. These routes are not fixed tracks: a student can move between them as evidence changes. This principle helps preserve both learning support and appropriate intellectual challenge.

A FOUR-STAGE METHOD FOR COURSE IMPLEMENTATION

At the first stage, the teacher defines professional outcomes and creates a small diagnostic bank. Each outcome is linked to prerequisite concepts and to an assessment task. For example, the outcome 'evaluate the operating suitability of an induction motor' may require understanding of synchronous speed, slip, current, power factor, and mechanical load. A short digital pre-assessment can include one conceptual item, one basic calculation, and one contextual question. The system records not only whether a response is correct, but also the type of misconception suggested by the answer. At the second stage, electronic resources are selected according to the identified needs. A student with weak conceptual understanding is directed to a short explanatory video and annotated diagram before attempting the main calculation. A student who has already mastered those ideas can begin with an industrial case and consult resources as necessary. Materials should be concise, compatible with ordinary devices, and consistent with course terminology. Electronic teaching materials and multimedia resources described in studies of digitally supported engineering training provide a useful foundation for such course design [2–4]. However, resource availability alone does not guarantee an adaptive educational experience; the decision rules linking resources to learning evidence are essential. At the third stage, each learner completes a professionally meaningful assignment. Consider the selection of a motor for a conveyor with specified duty conditions. Students receive a technical description, rated data, and operational

restrictions. They calculate or interpret the required parameters, compare possible options, and present the reasoning behind a selection. Students working along different learning routes may use different scaffolds, but must produce the same engineering deliverable. This protects assessment fairness and ensures that adaptation serves professional readiness rather than making the task easier without justification. The fourth stage combines feedback, revision, and reflection. Automatic feedback may identify incorrect numerical inputs or missing steps; teacher feedback should explain the engineering significance of an error. Students then revise their calculation or decision and write a brief reflection indicating what changed. Revision history becomes part of the evidence of learning. The cycle can be repeated for more demanding problems in electrical machines and renewable-energy-related courses. Thus, learning adaptation is continuous and based on demonstrated performance rather than on a single entrance test.

FORMATIVE ASSESSMENT AND DIGITAL LEARNING EVIDENCE

An effective electronic course should not confuse platform activity with competence. The number of logins, minutes spent watching a video, or number of downloaded files can indicate participation, but these metrics cannot show whether a student can select a device or justify a technical decision. Professional readiness requires evidence from calculations, annotated diagrams, short technical reports, and oral or written explanations. Therefore, an adaptive pathway needs an assessment matrix connecting every target competency to an observable action and a suitable feedback method.

Four complementary dimensions are useful for monitoring growth. The cognitive-technical dimension concerns understanding of physical and engineering relationships. The analytical dimension concerns data interpretation, calculation, and recognition of uncertainty. The communicative dimension concerns explanation and collaborative defense of a decision. The digital-information dimension concerns purposeful selection and critical use of electronic resources. Motivational engagement supports these dimensions but should be evaluated through responsible completion and improvement, not by superficial activity statistics. The indicators below form a proposed rubric that instructors can adjust to course requirements.

Table 1.

Proposed competence indicators for an adaptive digital course

Dimension	Observable student evidence	Feedback focus
Cognitive-technical	Explains operating principles and identifies key parameters	Conceptual accuracy
Analytical	Calculates, compares options, interprets a characteristic curve	Reasoning and error analysis
Communicative	Defends an equipment choice with technical arguments	Clarity and justification
Digital-information	Finds, checks, and documents relevant digital resources	Relevance and source reliability

THE ROLE OF INDEPENDENT WORK AND THE INSTRUCTOR

Adaptive pathways are particularly valuable outside classroom hours. In independent learning, students can revisit a difficult concept, review a worked example, answer a self-check item, and return to the original technical problem. The most useful independent assignments require a product: a corrected calculation, a comparison table, an equipment-selection note, or a concise safety explanation. A teacher may also provide an optional challenge task for students who demonstrate quick progress. This structure avoids reducing independent study to passive reading of electronic files. The teacher remains responsible for the accuracy and relevance of digital materials. Simulated behavior, simplified formulas, and equipment ratings must be identified as model assumptions where appropriate. Instructors should review common mistakes revealed by assessment, prepare additional explanations, and ensure that students with limited connectivity can access equivalent materials. If an electronic system recommends a route, that recommendation should be transparent and revisable. Student data should be limited to educationally necessary information and used to support learning, not to make unsupported personal judgments.

IMPLEMENTATION CONDITIONS AND LIMITATIONS

Practical implementation requires a reliable content structure, clear learning outcomes, manageable diagnostics, and instructor preparation. It does not require a complex artificial-intelligence platform at the outset. A learning management system with conditional activities, linked electronic resources, and a simple rubric can implement a basic adaptive sequence. The more important challenge is instructional coherence: each intervention must address a demonstrated learning need, and each task must lead to evidence of professional achievement. The present framework is a methodological proposal. It should not be interpreted as proof that adaptive pathways alone improve performance by a specified percentage. To test effectiveness, a course team would need comparable groups or a carefully designed repeated-measures study, common assessment tasks, explicit criteria, and analysis of potential confounders. Equipment access, the quality of the teacher's feedback, and the initial knowledge of students may all influence results. A responsible evaluation should document these factors instead of attributing all improvements to software.

CONCLUSION AND RECOMMENDATIONS

Adaptive digital learning pathways can make professional engineering instruction more responsive while preserving common requirements for knowledge and skills. Their central value lies in linking diagnosis to targeted support, professional tasks, feedback, and revision. For electrical engineering courses, the approach is particularly promising when it guides students from understanding machine principles to making justified choices about operating conditions and equipment use. It is recommended that course designers first define a small set of measurable professional outcomes; prepare short diagnostics for prerequisite concepts; provide differentiated digital resources; require one common technical deliverable for each learning unit; and evaluate progress using a transparent rubric.

Subsequent improvement should rely on student work and systematic teaching evidence. In this way, digitalization becomes an instructional method for developing professional reasoning rather than merely a channel for distributing electronic content.

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BO‘LAJAK PEDAGOGLARNI ZO‘RAVONLIK PROFILAKTIKASIDA OTA-ONALAR BILAN HAMKORLIKKA TAYYORLASH

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Annotatsiya. Tezisda bo‘lajak pedagoglarni ta’lim muhitidagi zo‘ravonlikning oldini olishda ota-onalar bilan hamkorlik qilishga tayyorlash masalasi yoritiladi. Hamkorlikka tayyorgarlikning mazmuni umumiy maqsadni aniqlash, suhbatni dalillar asosida tashkil etish, vazifalarni kelishish va bajarilgan ishni qayta ko‘rib chiqish orqali ochib beriladi. Pedagogik ta’limda foydalanish uchun oilaviy vaziyatni tahlil qilish, uchrashuv rejasini tuzish va hamkorlik topshirig‘ini ishlab chiqishga doir o‘quv mashqlari taklif etiladi. Talabaning tayyorgarligini baholash