Implementing Digital Teaching-Quiz Startegies in the Measurements Laboratory: New Perspectives on Student Motivation and Knowledge Retention

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Abstract: This paper presents the possibilities and methods of introducing digital teaching-quiz strategies in the Measurements laboratory at Kandó Faculty of Electrical Engineering. The quiz-based learning approach aims to enhance student motivation, reduce dropout rates, and improve the effectiveness of knowledge transfer. The study describes the preparation, implementation, and evaluation of quizzes, as well as the impact of this interactive learning environment on student participation and performance. The proposed approach highlights that regular digital quizzes can strengthen active learning, support continuous knowledge retention, and significantly contribute to the long-term development of engineering students' professional competencies.

Keywords: digital quizzes; interactive learning; student motivation; measurements laboratory; knowledge transfer; dropout reduction

5 Introduction

Fortunately, we have the opportunity to teach one of the core technical courses within the training programme (in 2025, electrical engineering training with the highest score threshold*) – Measurement Engineering. In our case, this means that all students of electrical engineering, regardless of the form or language of instruction, meet us during their studies. The material, tasks, problems and measurements of the course currently being taught have evolved over several decades, and it must be emphasized that the course is the result of decades of joint work with numerous highly qualified industrial and academic colleagues (Dr. Horváth Elek, Tényi V. Gusztáv, Baka Károly, Dr. Gellérthegyi József, Dr. Molnár János, Dr. Tuzson Tibor, Szauter Ákos, Dr. Molnár Zsolt). Indeed, while the fundamental principles of the theoretical themes currently covered and the measurements compiled in the laboratory remain unchanged, its teaching approach reflects the most recent developments in both didactic and technological terms. For example, in 2025, in four measurements of non-electrical measurement techniques, artificial intelligence will be used to process data, visualize results (graphs), and prepare evaluations (protocols) to foster 21st-century soft skills.

The course Measurements is one of the key components of the initial training in electrical engineering, which takes place over two semesters (Measurements I and Measurements II), including one hour of lecture per week (scheduled in blocked sessions during the first seven weeks – two hours per week) and two hours of laboratory practice. There are currently 7 × 2 hours of lectures and video performances complementary to the course. A total of 23 laboratory measurements (12 in the first and 11 in the second semester) are carried out during the laboratory part, each accompanied by detailed guidance and video-based measurement demonstrations.

The laboratory is equipped with both modern and older instruments, enabling students to compare and learn classical and modern measurement techniques. Computer-aided data collection and processing are becoming increasingly important, although some of the computers in use are already outdated. Nevertheless, the flexibility of education, the gradual integration of digital tools and the development of new measurement protocols all point towards modern education.

In recent years, the level of student motivation has been measured several times, and although there is an improving trend, student motivation remains relatively low. According to statistical data, the failure rate of mid-term exams remains high and the rate of absenteeism is also significant. In our experience, students often do not remember the material they have learned previously, even though repetition and reinforcement of knowledge are given special attention every semester.

These problems may be due to a number of factors: changing learning habits, passive use of digital tools, and lack of regular practice in acquiring practical knowledge. Engineering students increasingly fail to perceive the direct link between theoretical knowledge and practical lab tasks, which reduces their motivation and the completion rate of the course.

Against this background, it is necessary to renew the didactic approach and methodology in the teaching of the Measurements Lab. Our aim is to make the educational process more interactive, personalized and experience-oriented. One possible means of achieving this is the introduction of digital quizzes, which are built on students' active participation, immediate feedback and the progressive deepening of knowledge. This type of innovation in education can not only help to increase motivation but can also contribute to maintaining the teaching of Measurements as one of the strongest and most innovative core courses of the Kandó Faculty of Electrical Engineering.

6 Activities in the Laboratory

Our Education Goal

Our aim is to provide a basis for students to understand and apply measurement principles, techniques, and procedures in the context of laboratory training, not only at the theoretical level but also in practical contexts. We aim for students to learn the basic principles of measurement techniques through practical exercises: not just to read about how the instruments work in textbooks, but to engage with them directly—perform measurements, interpret data, and draw conclusions. Laboratory practice provides opportunities for students to work with instruments and procedures in a professional context, helping to ensure that measurement knowledge does not remain merely theoretical. In addition, it is important to adequately prepare students for the comprehensive examination at the end of the third semester, which comprises both theoretical and practical components, in particular the element of measurement technology. In order to pass the test, laboratory and measurement practice require continuous recall, application, and cumulative knowledge development.

Integration of Digital Learning technologies

Digital learning tools implemented in education, such as regular low-stakes quizzes, help students deepen their understanding through repetition and retrieval practice: research shows that such low-stakes assessments significantly enhance recall ability and long-term knowledge retention. [1] The resultant learning environment, which integrates practical exercises, instrument use, data processing, and feedback, contributes to transforming the Measurements from a mandatory course into a competence-development experience that students can rely on later in their professional practice and engineering careers.

The challenges of generation Z and education

The traditional distribution of university education – a distinct system of lectures and laboratory sessions – has worked well for many decades. However, with the emergence of Generation Z, it has become increasingly evident that this structure no longer meets the new learning expectations and cognitive characteristics of students (not to mention Generation Alpha, whose first members will begin university studies within a few years). Today's student wants not only to receive information, but also to play an active part in the learning process.

The traditional structure is dominated by frontal, passive modes of instruction, where students often play a receptive but not fully engaged role. Although laboratories offer opportunities for practical experience, students' attention, motivation, and concentration often wane, especially during long, monotonous measurement tasks. In our experience, many students engage in multiple activities at the same time (e.g. mobile phone use, social media engagement, or online presence), so attendance in classes does not necessarily imply real learning participation.

Generation Z, born between 1995 and 2010, represents the first truly digital-native generation. Having grown up in a continuous flow of information, multi-channel communication and immediate feedback form the basis of their cognitive functioning. According to McKinsey's research, this generation is 'True Gen', the generation of justice, which builds on authentic self-expression, pragmatic thinking, and community dialogue. For them, learning is not hierarchical but an interactive, community-based experience, where the use of digital tools is a natural part of information processing. They are capable of processing information from multiple sources simultaneously, demonstrating hypercognitive capabilities. At the same time, this continuous multitasking tends to reduce their ability to engage in deep concentration, as the brain cannot effectively shift attention between different tasks in the long term. [2] The members of Generation Z have been in contact with the internet, social media, and mobile technologies since early childhood. For them, the line between the online and offline worlds has become blurred, which significantly affects their concentration and attention management. As a result of continuous digital stimulation, their attention span has been reduced to a few minutes on average and, according to some research, to just over one minute. [3] Attention fragmentation stems from constant connectivity to social media platforms: short videos, rapid information exchange, and immediate rewards all contribute to weakening the capacity for deep focus. [4] However, they are highly adaptive and value-driven – they are able to make rapid decisions and process new information efficiently when the learning environment is interactive and relevant enough for them. [5] Generation conflicts among young people often arise from the fact that education still largely follows the methodologies of previous generations, while Generation Z requires more participatory, visual, and digitally supported forms of learning. They do not consider knowledge to be static: they want to see its practical relevance and expect immediate feedback on their activities. [6]

The traditional lecture–laboratory system therefore presents a major challenge. Frontal education is less able to maintain attention; in laboratories, measurement tasks often become mechanical if there is no immediate interactive connection between the instructor and the student. It is therefore necessary to transform the educational model: laboratories should not only be rethought as places where measurement procedures are carried out, but as interactive spaces providing an engaging learning experience.

Learning for Generation Z is a cooperative and visual process: they prefer to work in teams, receive digital feedback, and develop through experiential learning. Solutions such as student quizzes, interactive measurement software, or real-time data analytics offer them opportunities for active participation and effective use of short attention cycles. The laboratory of future metrology is therefore not only a place for using instruments, but also for developing digital competences, problem-solving skills, and teamwork. Generation Z is motivated by seeing the meaning of the activity, by receiving rapid feedback, and by having opportunities for autonomous decision-making during learning. The aim is therefore not only to transfer knowledge, but also to create a lively, data-driven, and dynamic educational environment that fits the expectations of today’s students and the engineering thinking of the future.

What educational didactic elements are we going to use

Nowadays, one of the major challenges of laboratory training in measurements is the problem of forgetting. Experience shows that students are able to acquire a significant amount of knowledge in a short period of time, but its retention and long-term integration into their practical knowledge system are difficult to ensure. The “quick forget” phenomenon is therefore not only a student issue but also a pedagogical challenge: how can knowledge be disseminated in such a way that it does not disappear from short-term memory within days or weeks?

As early as the end of the 19th century, German psychologist Hermann Ebbinghaus described the theoretical foundations of forgetting and, in his experiments, created the forgetting curve (Ebbinghaus, 1885). [7] This curve shows how fast memory performance declines after learning: 60–70% of the information acquired will be forgotten within 24 hours if there is no repetition. The process of forgetting is biologically determined – the brain conserves energy and retains only information that is regularly reused or linked to existing knowledge for long-term storage. Forgetting is therefore natural, but it has severe pedagogical consequences. Students, especially members of Generation Z, consume a large amount of information, but most of it is not integrated in a structured way into their knowledge system. Therefore, our educational goal is to make learning lasting through repetition, reinforcement, and prompt feedback, but this continuous transfer of knowledge is not feasible under the current curriculum. It is not possible to return to previous knowledge every hour, so there is a need for digital, interactive tools that automatically provide this functionality. [8] [9]

One of the most promising solutions could be the systematic use of a teaching quiz. The essence of teaching quizzes is to pose questions to students in small batches, without stakes, while providing immediate feedback. Such “low-stakes” quizzes can improve long-term knowledge retention by 20–30% by activating the “retrieval practice” mechanism – i.e., active recall. [10] [1] The systematic use of teaching quizzes improves memory consolidation more effectively than infrequent high-stakes examinations such as mid-term tests. [11]

In the Measurements Lab, we use teaching quizzes as a learning aid, not as an assessment tool. The aim is not to promote accountability, but to support memory retention. The short training quizzes that become available in Moodle are linked to individual measurements and can be retaken by students at any time. The quizzes provide a rhythm of repetition, as described by the Ebbinghaus curve: it is worth retrieving the information after one day, three days, and seven days after learning to create stable knowledge. Generation Z values traceability, transparency, and personalized feedback. We therefore organize laboratory exercises so that students can visibly monitor their progress and receive feedback for each measurement. In the traditional educational approach, errors were traditionally penalized, but we apply the principles of reward-based learning theory. If the student delivers on time and the test report meets the published criteria, an extra point is awarded – thereby strengthening not only discipline but also self-organization. The aim of protocol evaluation is to support the learning process, not to penalize errors. This “growth mindset” approach is in line with the expectations of Generation Z, who develop best through positive feedback and enabling environments. [12]

Generation Z also demands flexibility, psychological safety, and development opportunities in the workplace. The same applies to education: flexible learning pathways, mentoring, and adaptable workloads. [13] Our laboratory training is therefore modular – students receive at the beginning of the semester a schedule indicating which measurements they can perform and when. Considering breaks and replacement options, the pace of the learning process is predetermined. It should be noted, however, that the capacity of the laboratory infrastructure does not allow for fully individualized learning paces, but the large number of replacement and consultation options can help mitigate the resulting disadvantages. During measurement activities, however, individual autonomy increases learning responsibility and self-efficacy perception. [14 – this is our self-efficacy] [15] Mental health and development potential are also key factors. For Generation Z, excessive stress, unclear requirements, and negative feedback are demotivating. This is why we aim to communicate constructively and create a psychologically safe educational environment. Students can ask questions, express concerns, and receive feedback in the lab – not with the intention of being evaluated, but with the intention of developing. [16]

In the future development of the Measurements Lab, digital didactic elements will be integrated at all levels of education. One of these improvements is the production of guidance videos that show, step by step, the preparation of measurements, data collection, and evaluation processes. These videos will be available on the Moodle platform and will help students prepare and work independently. The use of video guides not only helps to maintain awareness but also supports the principle of multimodal learning – the student not only reads but also sees and hears the information, which, according to memory research, increases learning efficiency by 50–60%.

The integration of teaching quizzes into the Moodle system allows repetition and practice to be continually present in the learning process. These quizzes can be linked to lab tasks so that students can update their knowledge prior to each measurement by means of a short, targeted set of questions. Prompt feedback, scoring, and motivational elements (e.g., badges or commendations) create gamification effects, which are particularly effective in maintaining the attention of Generation Z.

7 Teaching quizzies

A “Teaching Quiz” or “T-Quiz” is a didactic tool whose primary purpose is to support the learning process rather than to serve accountability. We distinguish it from traditional quizzes primarily in terms of their function and perception: while the standard quiz is often presented as an instrument for evaluation – serving as both an assessment script and a measurement tool – the teaching quiz aims to activate and reinforce knowledge, and to support memory consolidation. Many perceive quizzes with pejorative connotations – ‘just a test’, ‘a list of questions at the end’ – but the teaching quiz has long surpassed this perception: as part of the teaching process, it is integrated into learning itself, rather than serving solely as an assessment tool. [12]

What is the teaching quiz?

The teaching quiz is a short, targeted set of questions that we apply throughout the learning process – not at the end of the course, but continuously. It provides immediate feedback, repetition, and pre-emptive reinforcement. A “no-stakes” quiz allows students to approach tasks with reduced anxiety, enabling them to focus more effectively on reinforcing knowledge. Research has shown that retrieval practice can be as effective, or even more so, than repeated re-learning for generating long-term knowledge. The teaching quiz is therefore not merely a “renaming” of the traditional quiz, but a methodologically reconceptualized learning support element. [12]

Types and structure of the teaching quiz

According to Racsmány, the structure and types of the T-quiz can be classified according to knowledge levels: factual, understanding, application, analysis, evaluation and synthesis issues. [12]

- **Factual T-quiz**: ask facts, definitions and data – for example: “Name...”, “What is...?” [12]
- **Understanding quiz**: capture the meaning and functioning of the topic – e.g. “Head...”, “Improve...”.[12]

- **Application T-quiz**: requires the application of the knowledge acquired to the new problem – “Calculate...”, “Choose...”[12]

- **Analytics T-quiz**: requires disaggregation, comparison, partial/whole relationships – “Analyse...”, “Why...?”[12]

- **Assessment T-quiz**: value judgement, critical thinking – ‘Assess...’, ‘What claim cannot be accepted...?’[12]

- **Synthesising/Creating T-Q**: calls for a new solution – “design, define..., Create...”.[12]

Proposed steps in the structure: a pre-test for the topic (short, simple questions), followed by a presentation of the curriculum, a short tutorial after the first part, with feedback, then a new topic part, followed by a quiz, etc. The timing of the repetitions is key: the frequency of quizzes is set according to the success rate – erroneous reminder → frequent repetition; successful reminder → less frequent repetition. [12]

Why would we like to use it in the measurements laboratory?

In a laboratory environment where students work with measuring instruments, collect, and evaluate data, teaching quizzes can be particularly valuable because they help develop “usable knowledge”: they do not merely assess whether students ‘know’ a concept, but whether they are able to develop, apply, and transfer it to new measurement contexts. The quizzes help to structure knowledge, build associative networks, and reduce students’ hesitation through repetition, thus supporting the development of long-term professional competencies. The teaching quiz is not an assessment tool, but a learning facilitator, thereby responding to contemporary learner needs and supporting the aims of the Measurements Lab, namely the development of competence-oriented engineering knowledge. This is particularly important for Generation Z, for whom learning is not merely a passive process, but an interactive, feedback-driven experience.

8 How to generate teaching quizzes

One of the key steps in the systematic implementation of teaching quizzes is the automated generation of questions or pre-structured quizzes, which can now be done much more efficiently with the help of AI-assisted tools. In our laboratory education environment – the course on Measurements– this means creating hundreds of questions based on textbook topics and generating them directly in Moodle-compatible format, so that they can be immediately imported into the learner interface. The great advantage of AI-based question generation is that it can be scaled up effectively and efficiently: many questions can be created for each chapter of the curriculum in a short period of time, thus continuously supporting the repetition mechanisms of the learning process. In addition, AI assistance allows for a variety of question types: different levels of difficulty, question formats and pedagogical interventions to be applied. [17]

Generation process

1. Selection of the theoretical content – the thematic chapters of the textbook serve as a starting point (e.g. 'Ohm's law and its applications', 'Digital multimeter errors', 'Data collection and signal-to-noise relationship', 'Bridge measurement with external sources of interference', etc.).

2. Prompt design for AI – provide the theoretical description and specify the desired question type (e.g. multiple-choice, true/false, short answer) and define the question format as Moodle-compatible exports (e.g. in GIFT format, which can then be imported into a question bank). [17]

3. Question generation and processing – AI generates a set of questions that are subsequently reviewed, refined, and formatted as necessary (e.g. error correction, pedagogical alignment).

4. Import into Moodle – completed questions are exported in GIFT format to the Moodle system and integrated into the course question bank, from which they can be inserted into the tuition and quiz module.

5. Rhythm of deployment and repetition – schedule the quizzes appropriately: a pre-laboratory warm-up quiz, an intermediate checkpoint quiz, and a follow-up quiz. Immediate feedback and performance statistics are available to both students and instructors after each quiz.

AI-based question generation can produce large volumes of question banks that enable frequent retrieval practice and promote interleaving. This is particularly important in overcoming the challenges associated with the “take-up curve”. Lab-adapted quizzes help students reconnect with their instrumentation activities throughout the learning process—not only at the moment of measurement but also later, in a more conscious and reflective manner.

Let’s see a simple example!

In this example, we will generate a first-level factual t-quiz:

The prompt:

As a university lecturer, a practicing electrical engineer works in the measurements lab to change the teaching mode and didactics. As part of this: It is processed in the form of a voltage measurement, T-arrow. Create 2 factual T-quizzes (a simple choice and a pupil) asking for facts, definitions and data – for example: “Name...”, “What is...?” from the topic of voltage measurement. Add the result in Moodle gift format.

The response:

```
Feszultseg_MC1:What is the term that can be defined as the physical amount of voltage? {
= Potential difference between two points
~Current strength on the cross-section of a conductor
~Resistance in a circuit
~Performance in the consumer
}

Feszultseg_Match1:Match the terms and meaning of voltage measurement. {
=Voltmeter -> Device measuring voltage between two points
=SI unit -> Volt (V)
=Mode of switching -> Volt-meter connects in parallel to the points to be measured
=Ohm Act signals -> U = I * R
}
```

Summary

In the learning–teaching process, teaching quizzes have become a central tool not only for assessment but also for creating active learning opportunities. The role of teaching quizzes lies in encouraging the development of knowledge (retrieval practice) through regular low-risk questions, thus contributing to long-term retention – not just short-term “evocation”. Research shows that regular quizzes can be a more effective tool to strengthen knowledge than re-learning alone. [18] At the same time, we need to be aware that our own forgetting is the main obstacle in education: after initial learning, memory retention drops rapidly; the so-called forgetting curve shows that much of the knowledge will disappear without repetition. This challenge can be addressed through teaching quizzes, as they can consolidate knowledge and transfer it into long-term memory through repetitive retrieval and immediate feedback. It is also important that our learning environment fits with different learning pathways and styles. Students have different learning styles – even if they do not have precise information on this: visual, auditory, and active learners – so teaching and learning should not follow a single template. The modular structure of the quizzes, offering choices, opportunities for self-practice, and prompt feedback, gives everyone the opportunity to progress at their own learning pace and get involved in a personalized way. Teaching quizzes are a strategic tool in our educational process – they help ensure that learning is inspired by experience, speedy, continuous reflection and tailored to individual needs. Overcoming misconceptions, adapting to learning styles and continuously nurturing knowledge can all be implemented with this tool. The aim is not only to remember and apply knowledge – so that laboratory training in metrology becomes truly effective and sustainable.

Authors' Declaration

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