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SMART BOARD: EVOLUTION AND APPLICATION IN HIGHER EDUCATION

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Abstract

Digitization means data is converted into a digital format that can be processed by computer equipment. Digital processing leads to digitalization, which has a significant importance, among other areas, in developing higher education. Assuming the goal is to graduate students with the highest possible level of knowledge and to enable them to perform their future jobs effectively, a strong emphasis must be placed on this field. The efforts are meaningless without renewing the teaching methods and environment; just adding some computers and software is not sufficient. The smart boards investigated in this study are advanced, integrated tools that support efficient digital education. The article presents the journey from chalkboards to digital boards, emphasizing the necessary steps for successful application. Students' feedback on a pilot application at the University of Pannon was processed to explore the opportunities and critical issues.

Keywords: *smart board, higher education, digitalization*

1. Introduction

Beyond literacy, language knowledge, learning ability, cultural awareness, entrepreneurship, citizenship, and STEM (science, technology, engineering, and mathematics), digital competence is listed as one of the key competencies for lifelong learning by the European Union (European Commission, 2019). It involves acquiring and effectively applying knowledge of information and communication technologies. The development of digital technologies is continuous; sometimes, the new solutions that become available are challenging to follow. At the application level, the pace must be slower if significant investments are needed, but as companies and higher education institutions, we must understand that efforts to implement the latest technologies are essential. At the same time, shaping the mind is important both for students and teachers. Competence has become a keyword in all educational programs that focus on students' skills and abilities (Berényi, 2023), but there are similar requirements for teachers and institutions as well.

Digitalization is decisive in all areas of life. It is particularly important in education, as public education and higher education must prepare students for the effective use of digital technologies. There are many opportunities available to make the acquisition of knowledge more effective and to make the learning process an enjoyable experience. Knowledge acquisition can be made more enjoyable by stimulating students' interest and motivation, which requires innovation from both institutions and educators (Karkó, 2024).

Universities have launched various programs to take advantage of the opportunities offered by digitization. A great example is the DigitALL (Digital Transformation of Education at the University of

Miskolc) project, which was launched in 2022. According to the report on the third milestone, 2,947 digital devices were installed, and 6,880 people received digital and foreign language education or training. The methodology of digital education and the infrastructure to support its operation were developed. Four hundred digitizing tablets and 20 Virtual Reality glasses were purchased, and special equipment for targeted chemical engineering training (University of Miskolc, 2025). The example underlines that meeting the challenges of digitization is a complex challenge: it requires the coordinated development of knowledge, tools, and methodology.

A model change by law in the Hungarian higher education system was implemented, transferring ownership from the state to foundations or corporations to ensure higher efficiency and overcome the limitations of state-ownership. The changing environmental requirements are evident in the fact that the number of computers has increased by more than 20%, which entails significant costs, but the investments have resulted in an increase of more than a third in the number of students using computers *(Figure 1)* (Hungarian Central Statistical Office, 2024). It must be noted that the trend break is apparent only in *Figure 1* due to methodological changes introduced by the Statistical Office, and the data for 2014/2015 and 2015/2016 are estimates.

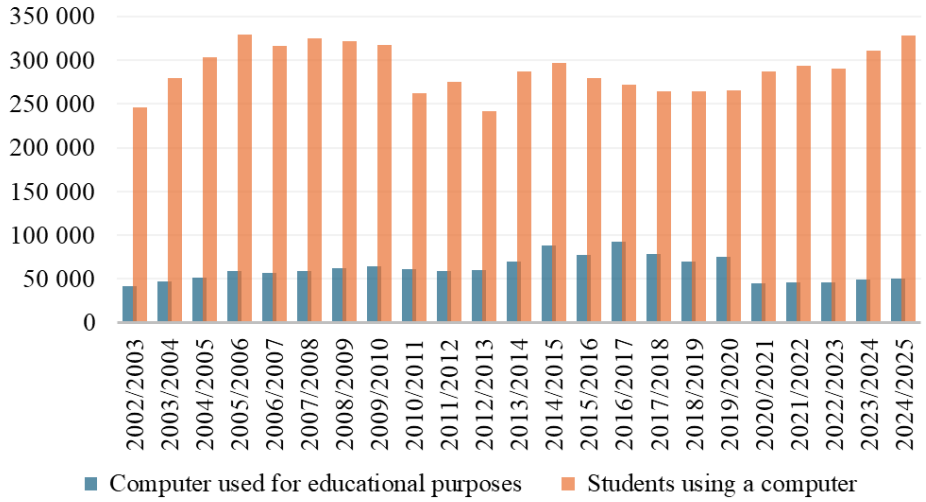

Figure 1. *Computer use and availability in higher education* (KSH, 2024)

A significant step forward if the main reason for using computers is not just browsing the internet for sources, even in the classroom, but supporting modern educational and scientific activities. Another example is provided by the University of Pannon, where modern methods are acknowledged and mirrored also in the number of students (University of Pannon, 2025). The study presents a case study of a successful innovation initiative that integrates technological achievements and educational methodology issues.

Beyond their contribution to lifelong learning, digital competences are included in the Sustainable Development Goals (SDGs). Eurostat and the Central Statistical Office of Hungary collect and analyze data on skill levels to monitor progress. The results in digital literacy (Hungarian Central Statistical Office, 2022) show that a large proportion of the population has some digital skills. In Hungary, less than a quarter of the population had general digital skills above the basic level in 2021 *(Figure 2)*. This

means that they were able to perform more serious tasks than just writing text and browsing social media sites. The Hungarian population exceeds the EU average in terms of basic general skills, and I believe this has improved significantly over the past five years; however, this is not the primary objective. In the category above the basic level, Hungary lags.

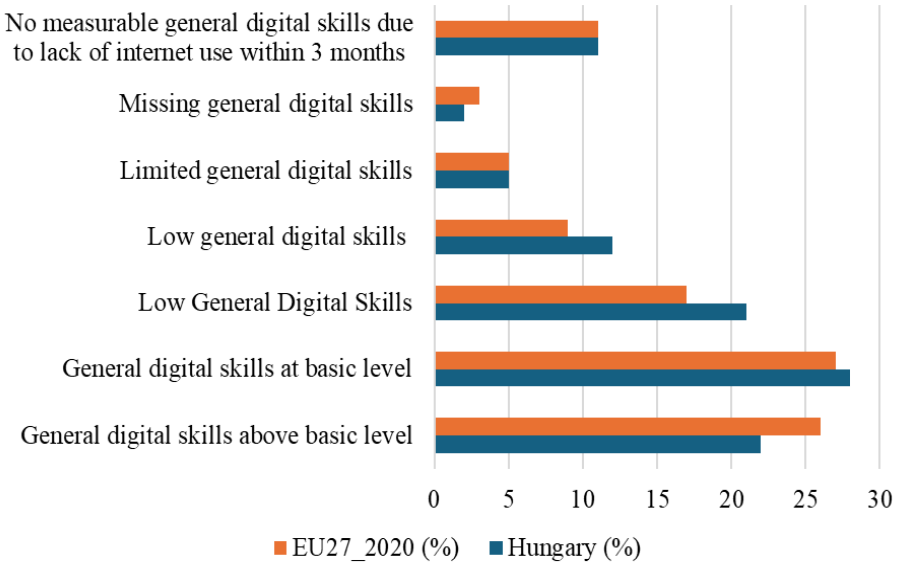

Figure 2. *Digital literacy comparison between Hungary and EU*
(Hungarian Central Statistical Office, 2022)

Moreover, governmental support is essential to improve digitalization. That covers establishing the legal environment and direct financial support as well. According to a statement by the Hungarian government spokesperson, the biggest challenge facing education systems is digitalization, and significant state developments are therefore taking place in the Hungarian education system to reinforce this (MTI, 2023). The purpose of digitization efforts is to increase efficiency, so it is a tool and not a goal. In quality education, it supports the development of skills, but specific skills are needed in advance to use them effectively. Digital education can develop many abilities and skills, such as problem-solving skills, which can help effectively solve various situations that arise in everyday life (Silber-Varod et al., 2019).

2. Materials and methods

The availability of the technical background, including hardware, software, and networks, is not sufficient on its own to exploit the digitalization opportunities. It can be considered a new technology that covers the technical background and the technique contributing to the successful application (Pataki, 2014; Deutsch et al., 2019). Regarding the scope of the study, it means having the necessary skills and competencies by teachers and students. Acceptance of the technology and a systematic approach to using the proper tools are the key factors. Ultimately, a quality management approach is required to ensure that all interested parties are served (Szintay, 2005; Berényi, 2017); in this case, an emphasis on teachers and students is particularly important.

That leads to the research question of the study: how to support educational modernisation in the digital age through smart boards. Due to the complexity of the influencing factors, the responses and application processes are difficult to foresee. Best practices in the field may contribute to effective strategy making and system development. Therefore, case studies are purposeful. The study presents a pilot case study of the University of Pannon, where a comprehensive test has begun. Beyond general efforts in digital education, the Faculty of Economics has established a specialized learning environment with a smart board system, new teaching methods, and learning materials. Of course, students' opinions are monitored continuously.

The assumption was that lessons held with the support of smart boards greatly improve communication, which is essential in life, as it is not only necessary to communicate in writing on social media, but also to hold one's own in various meetings in the business world. Improved problem-solving skills and IT knowledge is also expected.

The paper reviews the evolution of technical tools supporting classroom education towards smart boards, the personal aspects of the development and the system developed by the University of Pannon. Additionally, the results of a survey is presented that was conducted among the users involved in the pilot project. 79 students and 20 teachers answered the questions about their experience with the samrtbord system.

3. The evolution of technical tools

3.1. Towards smart boards

The systematic approach to successful digitalization of education requires knowledge of the past, as it has become part of the culture, and gradual change is better assumed during the process. That means more or less modern solutions are used in parallel, influencing each other.

Various teaching devices and aids have always been part of education, and digital tools have been available for about fifty years, but their spread has only been truly significant in recent years. Reviewing the evolution of these tools is important not only from a technical historical perspective but also for highlighting the mistakes and shortcomings that hinder effective use of the digital environment. Teachers often try to combine old methods with new tools, guided by old habits and customs, which can easily lead to failure. The following paragraphs review the development of classroom tools:

- Chalkboard: The advantage was that the material could be erased, rewritten, and corrected multiple times, but it could not be uploaded anywhere in a digital form. A harmful impact was the flying chalk dust, which many people are sensitive to. Another disadvantage was that some students, especially those with special educational needs, could copy the content more slowly; as a result, they were unable to follow the lesson, leaving them at a significant disadvantage. The chalkboard was not a digital device at all; at most, it supported digitization by being foldable in more modern classrooms, and its interior was white so it could be used for projection. Nevertheless, these boards and their modernization are the starting point for the digitization of the classroom.
- Overhead projectors and digital projectors: Several types of projectors emerged, the most important being the overhead projector, which is still in use today. The teacher had to prepare the learning material on a transparent film, which could then be projected to the students. One advantage was that the projector could illuminate 3-4 transparencies, making the teaching material more visual. Later, photocopiable transparencies became available, but the lower-quality ones melted onto the photocopier roller, resulting in high costs for institutions. Modifying the content on the transparency was cumbersome and could only be scanned in retrospect.

- Visual boards: Originally, visual boards were not digital devices, but they were well suited for displaying digital information via a projector. This had a huge advantage over the chalkboard, as there was no chalk dust, but they can be used with special pens. A disadvantage is that if a colleague uses the wrong felt-tip pen, chemicals are needed to erase it. Unfortunately, the written teaching material cannot yet be uploaded.
- Digital projector: Projectors, which are still widely used today, are extremely useful in education, as they allow teachers to project information from their computers to their students, but asymmetrically and non-interactively. Digital versions of the projected material can be distributed to students, which enables them to focus more on the message of the teacher instead of copying the projected content.
- Portable typewriter: As an educational tool, typewriters come to mind at most in connection with the production of teaching materials. The digital Rosytext Mini *(Figure 3)* offered much more than that; it was an early digital solution for creating nd editing learning materials. The typewriter, a screen, a floppy disk drive, and a printer were built into one device. It was economical because documents stored on the floppy disk could be modified at any time. Unfortunately, the floppy disk could only be used with this machine, as after formatting, the computer could not recognize it, and vice versa, i.e., the Rosytext Mini floppy reader could not interpret the computer's formatting. A printer assured the analog connection to the target audience. Modern solutions serve the same purpose but more efficiently. E.g., a PDF format can be read on several devices. Rosytext Mini is a historical example of digitalization purposes.

Figure 3. *Rosytext Mini and its printer* (own photo)

3.2. Smart boards

The current state of evolution is the smart board. It became widely used in education a few years ago, but its advantages are rarely exploited (Akar, 2020; Al-Qirim et al., 2020). We often see it being used simply to replace a projector, rather than as a complex system. General functions include the use of Word, Excel, and PowerPoint applications, which allow for the digital management of texts,

spreadsheets, and images, even dynamically. However, its usability is not limited to these possibilities. It is advisable to have a camera for the smart board, usually two: one for students and one for teachers. In the background, educational systems are needed, such as Moodle, which integrates teaching materials, students, assignments, and their scheduling.

The teaching material information can be modified an unlimited number of times and, very significantly, can be saved and uploaded to the Moodle system. The smart board can also be used for interactive teaching, allowing students to solve tasks or parts of tasks (mathematics, logistics, production) directly on the board. The advantage of this is that mistakes can be corrected immediately and quickly. In addition, students' communication and presentation skills can be developed without the teacher having to make a special effort to do so.

The smart board can also be used for various innovative tasks, especially in professional subjects. This also applies to practical tasks, which can be solved very easily with the help of the infinite whiteboard (especially for tasks requiring drawing). The infinite whiteboard comes with pens of various thicknesses and colors, an eraser, a camera, and countless drawing and diagramming tools.

If it is possible to install multiple smart boards in the classroom, they are excellent for team collaboration:

- independent data collection and research, as well as analysis,
- arguing a given topic,
- forming opinions about each other's work and solving various innovation tasks, for example, explaining why one solution is better than another student's solution,
- various risk analyses,
- and simulating and solving decision-making situations.

4. The personal side of educational digitization

The question for discussion can be formulated as why the digital innovative education was practical (Qian et al., 2024). The goal of higher education, as well as vocational training centers, is to prepare students for their future tasks and enable them to leave the university with the highest level of knowledge. Students must also be motivated during their education, because students who are sufficiently motivated are more committed and feel better at university, and they can also enhance the university's reputation, as word of mouth is the most effective form of advertising. However, this motivation can be applied not only to students but also to teachers, who also need motivation, which can take the form of home office, flexible working hours, study trips, or various forms of recognition.

Control is also important when applying digitalization, for which several programs are available in higher education. One software is Moodle (Gamage et al., 2022), which allows various tasks to be assigned during the course, which students can easily complete on their mobile phones or laptops, and then check the correctness of their solutions.

Another question is how digital tools can be used effectively. It requires a logistical mindset, in which it is advisable to familiarize oneself with the tasks in their entirety. It is not enough to look at a small part of the task to be able to solve the problem effectively; a comprehensive overview must be approved.

On the other hand, teachers' creativity is essential for the effective use of tools and to take advantage of the benefits of digital education (Ndwandwe et al., 2024). Considering smart boards the accepted framework for digitized education today, this means that all participants must understand their capabilities and learn how to use the system. Effective teaching materials and methods can be developed only if the motivation of the audience is assured:

- A teacher can motivate others when the teacher is motivated: In addition to being able to use digital tools at a high level, teachers must show commitment to them and encourage students to share their enthusiasm. Rewards and recognition are also necessary, and gamification offers a solution.
- Technical tools can support effective motivation: An excellent example is interactive task solving in classes, both individually and in teams. The process can be easily monitored on the smart board, and gamification elements can be used to provide instructor and peer feedback (voting, scoring, and commenting).
- Using all features of digital devices requires familiarity with the technical device's capabilities.
- Linking the message to the practice: Practical examples can give a new meaning to the learning materials.
- Asking questions and making suggestions: It is essential to dare to ask questions when problems arise. Of course, this also requires having someone to ask. Feedback is a valuable source for further development.
- Testing the tools: Before using any digital tool in the class, it is always necessary to test the features, including technical and content issues. That way, students see a well-functioning system, and their trust can increase.
- Passing best practices and lessons learned: It is important for teachers to share their lessons with colleagues. Beyond expanding individual knowledge, this helps establish a uniform practice for using the tools, which also increases student acceptance, as they encounter the same procedure across classes and topics.

5. Case study of the University of Pannon

The University of Pannon decided to use smart boards to support classroom work and develop its teaching methods. A separate lecture hall was designed for 50 students to take advantage of all the benefits of the smart board system and to provide space for experimental developments *(Figure 4)*. The room has been equipped with a large smart board in place of the chalkboard, a rear screen on the back wall, and medium-sized screens at every second row of seats along the side wall. A full conference audio and video system is available with automated functions. A control computer was also installed that allows the integration of the system, including monitoring students' workspaces (not used yet). That means that students could share their ideas, materials or presentation from their own tablet with the others and/or the large screen.

The core element of the system is the smart board and its software. The operating system uses an infinite whiteboard, which allows placing any information, application windows, or free-form text on the surface. The infinite whiteboard is well-suited for recording various mathematical, mechanical, and chemical formulas and equations, as well as for extracting and focusing images from the internet and other applications. It can be used to create various diagrams and drawings and to share them with students via Moodle. The application supports multiple recording methods, and since the board is equipped with a dual-office device, students can present their imagined solutions to tasks on the board and practice, thereby improving communication and scientific knowledge. The browsing option on the initial screen provides regular Internet access, and the results can be placed and relocated freely on the whiteboard. Any pre-installed applications can be managed similarly. Word, Excel, and PowerPoint are common tools for communication, but targeted simulation software can be used.

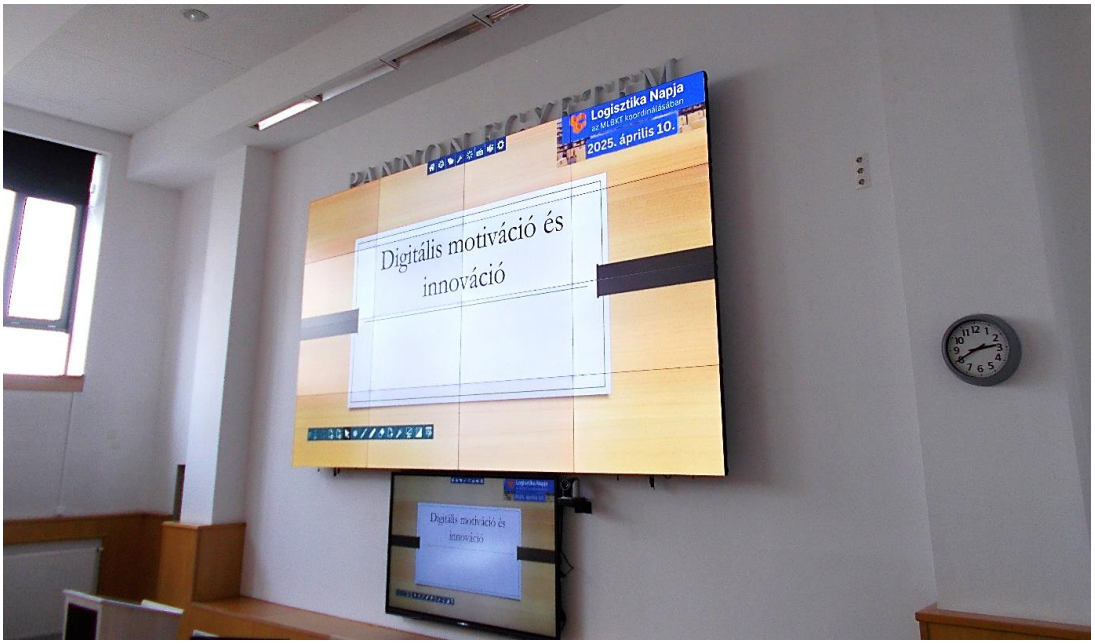

Figure 4. *Lecture hall at the University of Pannon smart board system* (own photo)

The use of the smart boards can demonstrate their success, as well as point out the scope for improvement. Among the three main options available on the initial screen, applications are the most popular among teachers. Internet usage may be relatively low because colleagues do not search for the necessary information directly in the classroom.

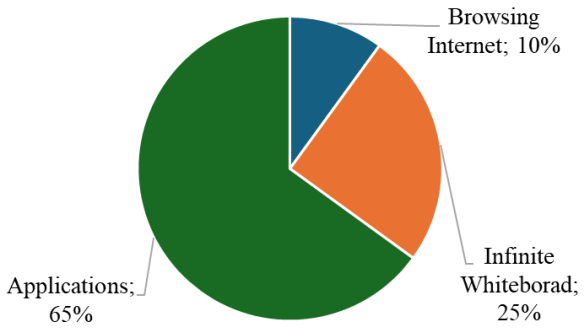

Figure 5. *Most frequently used feature of the smart board system (% of the teachers)*

Group tasks support learning collaboration, and making a simulation of a modern international business environment. Such tasks were assessed as good or very good by 86% of the students *(Figure 6)*. Most students noted that they consider group tasks more valuable to gain a competitive advantage in the labor market.

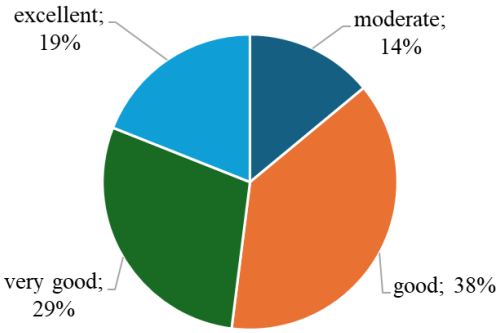

Figure 6. *Students' assessment of group level tasks (% of the students)*

A general assessment of learning with the smart board system confirmed its usefulness. 35% of the students marked it as an excellent way of learning, 61% rated it good or very good, while 4% rated it moderate. Since it is a pilot project and broad experience is not available, direct feedback from the students were used instead on complex evaluation surveys. The voluntarily answerable open question about the opinions was as follows:

- The interactive whiteboard itself is interactive. I think it's very useful; it keeps the class's attention.
- It's much better than traditional blackboards because of its many uses. The teacher is well prepared in its use.
- The teacher uses the board in a way that would be the envy of any Generation Y or Z. The use of the smart board significantly increases interactivity in class and student engagement. It helps make the curriculum more visual and accessible, thus facilitating more effective learning. It allows for the use of multimedia content, presentations, and interactive tasks, which is particularly useful in differentiated teaching. However, its use requires preparation on the part of the teacher, and the teacher manages to keep up to date in this regard.
- I am glad I had the opportunity to try it out... I think it is an extremely useful tool for modern education.
- Fast and efficient I really like this type of board; I have not encountered anything like it at other universities. It helps students follow the lesson, and the material is easy to read even from the back row. I think the lecturer uses it appropriately; I have no complaints.
- The teacher is clearly skilled and confident in using the board. I find his presentation very inspiring because I can see that it has many more possibilities than I first thought. Both for projection and for lectures. The smart board application is very good because I haven't had the opportunity to use one before, so I found it useful. The lecture was also illustrative, and I encountered practical procedures.
- The smart board is a useful tool that significantly facilitates the teaching process; you can write on it and project teaching materials onto it at the same time.
- The presentation was very interesting, and the tasks to be solved during the lesson were also appropriate. Paint works the same on the smart board as it does on a computer (with all its advantages and disadvantages), but the pen is really great to use.
- The presentation is interesting, and group tasks and videos help to keep the audience's attention.

The responses confirmed the needfor systematic approach in using the modern methods, as well as the success of the pilot project. The students highlighted the preparedness of the teacher in using he new technology. The carm of novelty is also high: well-known digital solutions used in other areas by the students can be applied for learning purposes.

6. Conclusions and further opportunities

Based on the review by Balogh (2023), the benefits of digitalization for higher education institutions can be summarized as follows:

- student and teacher motivation increases, thereby boosting the popularity of the higher education institutions and increasing student enrollment,
- reliable and educational materials are available (in the case of smart boards) to students, and through the Moodle system students can access them at any time,
- individual digital skills can also be developed by students and teachers,
- a digital knowledge base can be shared among teachers,
- manual work is significantly reduced, increasing teachers' efficiency,
- digital materials can save a lot of time, which can be spent on innovation,
- paper use reduction results in cost savings in material expenses. Of course, this means that modern tools are needed for digitization.

The most important advantages of smart board-supported teaching are student motivation and the ease of conveying and recording the curriculum. The most important future possibility is the implementation of practice-oriented professional education in special case study laboratories. In addition to purchasing the equipment and providing the technical infrastructure, the effective use of these tools requires developing teachers' knowledge and motivation (Urhahne and Wijnia, 2023), as well as rethinking teaching materials and educational processes.

The ultimate beneficiaries of the system are the students, whose opinions are relevant from the perspective of quality assurance and educational development. Experience shows that the vast majority of students are satisfied with digital teaching tools and their use.

The pilot project at the University of Pannon confirmed the need for a systematic approach to harmonize the technical tools, the skills, and the participants' commitment. The case study presents a radical innovation in teaching, but its gradual introduction is important; it is impossible to create all learning materials and methods overnight. The students' assessments emphasize the modern nature of this learning way. Gradually showing the benefits can improve the acceptance of the technology. At the same time, a fall of this 'wonder' may be expected in time; therefore, it is important to make the technology a part of the daily routine as soon as possible.

The paper concludes that students will receive digital education supported by smart boards, but the question arises of how to make it even more effective and sustainable. Ultimately, information technology has become a key issue in development and success. Its contribution to corporate value creation is well-defined and measured with business indicators (Nemeslaki & Aranyossi, 2005). A similar approach must be established in higher education institutions as well.

Of course, as there is a continuous and remarkable development of IT tools, the opportunities of smart boards are not closed. The pilot study is limited to one successful application of smart boards, but he practices may offer examples to institutions. Based on the limited experience to date, further development is essential. It would be worthwhile to develop classrooms with smart boards built into students' desks, displaying the same information as the teacher's computer and allowing students to take

their own notes, which they can save for later use. If these notes are also available to the teacher, student progress can be better supported and individually corrected, and useful elements can be shared at the group level. Of course, in addition to the technical requirements, several data security and privacy issues need to be clarified in higher education, and especially in public education.

As a content element, it would be beneficial to establish a practice lab where real-life case studies can be analyzed. Contracts with companies could be used to involve practitioners, who could even appear as guest lecturers. In the latter case, however, the high level of technical knowledge required to use the equipment is questionable; through long-term cooperation, the company can, however, select its future employees from the university's benches based on their relevant experience.

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