Digital transformation in education: ASEM case study and the integration of modern technologies in the learning process

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Abstract
In the conditions of European integration the development of the Republic of Moldova will have a special connotation, namely - the adjustment of the society to the requirements of a highly digitalized European society. In the article the authors aim to emphasize the importance of integrating information and communication technologies in university education in the Republic of Moldova in order to meet the requirements of a modern society. The main objective is to assess the impact of digitization on the educational process in ASEM. The research conducted in the article is an analysis of the current state of digitization in the Republic of Moldova, with a case study focused on the implementation of the digital teaching-learning-assessment process at ASEM. This approach is based on observing how digital platforms and tools can enhance student autonomy through online collaboration and support teachers in adapting teaching methods to current requirements. The presented **results** conclude that the digitization of education at ASEM not only improves the academic results, but also contributes to the increase of teachers' competences by diversifying the working methods.The key contribution of the article is to highlight the importance of digital competences for the European integration of Moldova and to demonstrate how ASEM can become a model of digital transformation in education. This is an original approach that underlines the need for sustained efforts in maximizing the use of technology in education, as digitization is considered a central pillar in national development.

Keywords: digitization of education, Information Technologies, learning-teaching-assessment process, university education, SMART education.

1. Introduction
Digital transformation represents a critical process for modernizing and improving the efficiency of various economic and social sectors, thereby contributing to increased competitiveness and enhancing the quality of life for citizens.

The digital transformation of education is a comprehensive process designed to optimize the learning experience and address the demands of an increasingly digitized society. The possibility of digitalizing education emerged with the advent of the Internet, profoundly and permanently impacting the education sector.

Starting in March 2020, the COVID-19 pandemic significantly accelerated the digitization process, forcing educational institutions worldwide to close their doors and rapidly shift to online teaching to ensure continuity in education.

The COVID-19 pandemic has accelerated this digital transition, prompting public institutions to move from traditionally delivered services to online services. [1] COVID-19 exposed the vulnerabilities of traditional education systems and hastened the adoption of digital technologies in schools and universities. The study *"Digital Learning in Higher Education: COVID-19 and Beyond"* (Smith et al., 2022) [2] demonstrates how the pandemic expedited the implementation of educational platforms, with Moodle being used by over 70% of European universities during this period.

This research aims to explore the challenges and opportunities of digital transformation in Moldova's education system, focusing on accelerating the process toward creating a Smart Education system.

The rapid transition to online teaching revealed the weaknesses of traditional educational systems and underscored the need to adapt to new technologies. Despite numerous challenges, including inadequate infrastructure and limited teacher training, online education proved to be a necessary solution for addressing educational needs during the crisis.

The rapid digital transformation, initiated by the need to continue education under difficult circumstances, profoundly impacted Moldova's education system. This process has become a catalyst for modernizing education and is expected to continue and expand in the coming years. In the context of the rapid advancement of information and communication technologies (ICT), educational systems must adapt to meet the demands of a knowledge-based economy and society. Integrating emerging technologies such as artificial intelligence (AI) and augmented reality (AR) promises to transform education into a more interactive and personalized experience.

As digital education becomes a central pillar of modern learning, Moldova is focusing on strengthening and expanding its digital educational infrastructure. The digital transformation of education is not merely a response to global crises but also an opportunity to prepare the younger generation for the challenges of a technology-driven economy and society.

Thus, the digitalization of education in Moldova has become a strategic objective, significantly impacting the future of education and the development of digital competencies in new generations.

This study's core contribution lies in the detailed analysis of digital transformation in Moldovan education, highlighting strategic steps and the long-term impact of this process. Moldova's educational policies are aligned with European and international frameworks, which makes this analysis relevant for addressing the current challenges and needs of the education system and its beneficiaries.
International strategies for digitalizing education systems, such as *Smart-Edu (*Romania*)*, have influenced the need for a strategic direction in Moldova's *Education 2030 Strategy* [3] and other strategic documents.

In light of the rapid global digital transformations, it is essential for Moldova to develop a coherent strategy for creating a Smart Education system. This study includes a case analysis that examines digital transformations in Moldova's education system, using the digital initiatives implemented at ASEM as a model for establishing a Smart Education system.

Given the rapid pace of educational digitalization, this study clarifies and delineates the fundamental concepts of Smart Education, emphasizing their essence in the context of profound global educational transformations. These concepts are critical for understanding how emerging technologies and innovative approaches contribute to creating more interactive, personalized, and accessible education, thus preparing future generations for the challenges of a digitized society.

2. The concept of "SMART" in education

The concept of "SMART" in education has evolved over time and been interpreted in various ways, reflecting technological and pedagogical developments. Schematically, Smart Education can be illustrated as follows:

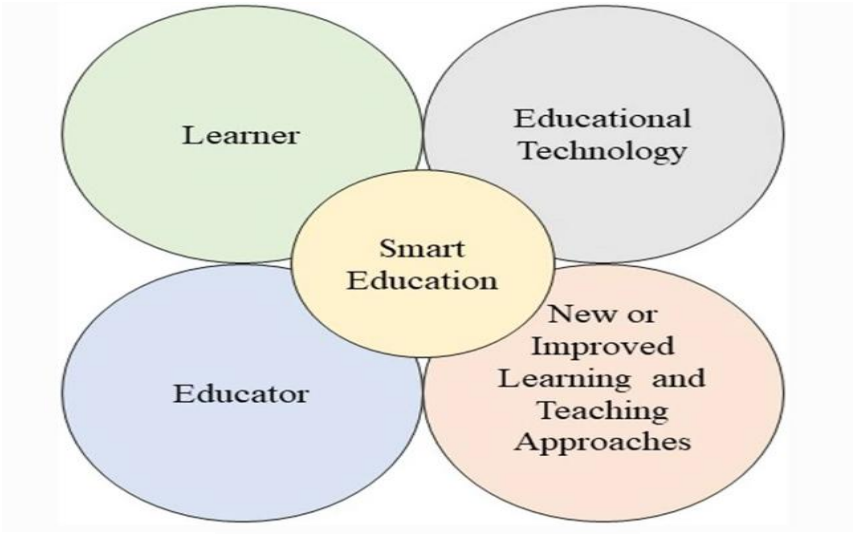

Fig.1. Essential elements of smart education
Source: [4]

Various researchers have differing opinions regarding the definitions of SMART Education. Before delving deeper, it is essential to clarify the concepts that, in the authors' view, are gaining prominence:

1) E-Education refers to the use of electronic media and tools to facilitate learning, including computers, the internet, and digital platforms for delivering education.
2) Digital Education encompasses the broader application of digital technologies, including online courses, Learning Management Systems (LMS), and digital tools to enhance educational experiences.

3) Smart Education integrates intelligent systems, personalized learning, artificial intelligence, and data analytics to create adaptive learning environments that improve student performance.

These definitions reflect the diversity and evolution of the concept of intelligent education, illustrating how technology and pedagogy converge to create more efficient and accessible learning environments.

Let us focus on the final concept, which encapsulates all the previous ones. To do so, we review the definitions of "SMART" used in education:

Table 1. Concepts and Acronyms of SMART Education in Specialized Publications

The concept and source	Characteristic
1. SMART Education as an Acronym for Science, Mathematics, Aerospace, Research, and Technology Source: Thomas & Carruthers, 2003 [5]	This definition was introduced by Thomas and Carruthers in 2003, focusing on the key academic fields that form the foundation of intelligent education. S.M.A.R.T. was used to describe a curriculum integrating these fields to prepare students for careers in science and technology.
2. SMART Education as an acronym in the context of Self-directed, Motivated, Adaptive, Resource-enriched, and Technology-embedded. Sourse: Keris, 2011 [6]	This definition was proposed by the Ministry of Education, Science, and Technology (MEST) of South Korea as part of the 2011 Smart Education Advancement Strategy. MEST decomposed the term SMART in the context of intelligent education to emphasize the characteristics of smart education. The acronym SMART was broken into five components to highlight the essential features of intelligent education, focusing on personalized learning methods integrated with technology.
3. SMART Education (Situated learning, Mastery learning, Adaptive learning, Reflective learning, and Thinking tools) *Source: Meng (2020)* [137]	Meng (2020) considers that smart pedagogy includes the following key elements: SMART (Situated learning, Mastery learning, Adaptive learning, Reflective learning, and Thinking tools), curriculum design, and teaching strategy. It is evident that smart pedagogy focuses on instruction and learning but is significantly different from education. Smart education emphasizes the support of intelligent technology, as highlighted in the following studies.
SMART Education as part of the initiative.	
4. SMART Education as part of the "Smarter Planet" initiative Source:: Palmisano, 2008 [8]	In 2008, Palmisano, CEO and President of IBM, launched the "Smarter Planet" initiative, which also included smart education. It emphasized the importance of utilizing advanced technologies, such as cloud computing, to transform education and make it more accessible and efficient.
5. SMART Education in the context of urban communities and schools Source: Rothman, 2007 [9]	Rothman (2007) discussed how districts and communities can create smart education systems in urban schools, emphasizing collaboration and the use of informational resources to enhance the educational experience.
SMART through ICT technologies.	
6. The development and progress of SMART education through ICT technologies.	In 2009, Jim Rudd and others highlighted the role of cloud computing and other smart technologies in the education of the future in the IBM RedGuide publication. Source: Jim Rudd et al., 2009 [10]

		In 2011, Vlad and his colleagues mentioned the use of notebooks and information technology to build SMART education platforms. This allowed students to better understand electronic components and simple circuits, emphasizing the importance of technology in education. Source:Vlad et al., 2011 [11]
		A definition provided by Zhu and He (2012) [12] is that "the essence of smarter education is to create intelligent environments through the use of smart technologies, so that intelligent pedagogies can be facilitated to provide personalized learning services and enable learners to develop wisdom talents that have a better orientation towards values, improved quality of thinking, and stronger behavioral capacity." In 2016, the authors Zhu and Yu. [13]mentioned another definition of SMART education as "the concept of learning in the digital age." Source: : Zhu et al., 2012-2016 [20,21]
		According to Bajaj and Sharma (2018), smart education is "about providing personalized learning, anywhere and anytime." Source: Sharma, 2018 [14]
SMART education according to the OECD		
7.	The main characteristics of smart education highlighted by the OECD include Personalization, Data utilization, Hybrid learning environments, Blockchain for accreditation, and Assistant robots.. Source: OECD Digital Education Outlook 2021 [145]	The OECD defines "SMART education" as an approach that leverages advanced technologies, including artificial intelligence, blockchain, and robotics, to transform the way education is delivered and managed. According to the OECD Digital Education Outlook 2021, smart education involves the integration of hybrid human-artificial information systems that support teaching and learning processes, with the aim of enhancing the effectiveness, equity, and cost-efficiency of education systems.

Source: Elaborated by the authors based on the works: Report on National Smart Education Framework [16], OECD Digital Education Outlook 2021, [145]

Definition proposed by the authors: SMART education is the coherent and efficient use of information and communication technologies (ICT) to facilitate personalized learning and develop advanced competencies in a collaborative environment through innovative and adaptive pedagogical methods. It transforms the educational environment into an intelligent one, promoting critical thinking skills, adaptability, and value orientation.

3. Evolution of smart education: Accelerating digital transformation

In recent decades, education has evolved significantly, especially due to the impact of digital technologies. This rapid change has been driven by the need to adapt educational systems to an increasingly digitized world. Thus, the concept of Smart Education has begun to gain ground, representing a profound transformation in the way we learn and teach. Compared to traditional education, Smart Education brings a series of innovations that not only improve the educational process but also make it more accessible and personalized.

It is important to note that the essential difference between traditional education and Smart Education is the way technology is used to support the educational process (see fig. 2).

However, traditional education does not necessarily need to be abandoned; many of its values, such as direct interaction between teachers and students, can be integrated into new

educational models. In fact, a successful educational system should combine the best elements of both approaches, creating a learning environment that leverages both modern technology and traditional human teaching.

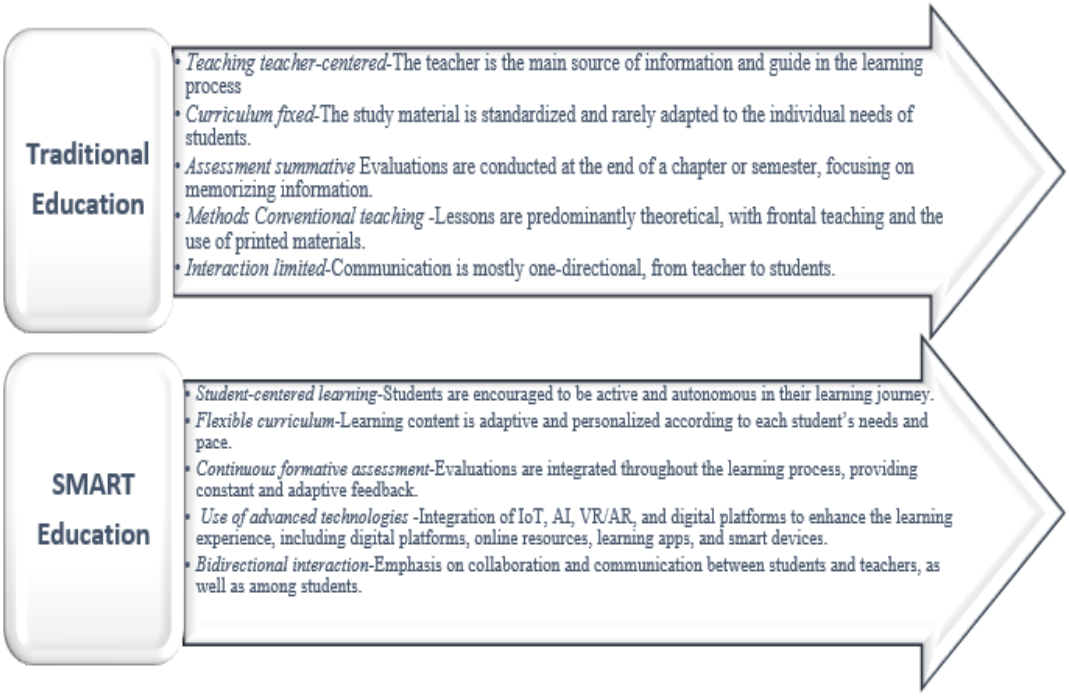

Fig. 2. Characteristics of Traditional and SMART education systems.
Source: Elaborated by the authors based on the works

The digitalization of education offers a more flexible, personalized, and accessible system, capable of more effectively meeting the diverse needs of students. The acceleration of digital transformation has led to the emergence of Smart Education, which enriches personalized learning through the integration of intelligent systems, artificial intelligence, and data analytics, thereby creating adaptive educational environments tailored to each student's performance and learning pace.

Smart Education has gained significant global attention in recent decades, with many educational projects being implemented in recent years. This activity began in 1997 in Malaysia, which first launched a Smart Education project, and later, in 2002, the Smart School Implementation Plan in Malaysia. Seven countries are pioneers in this field of educational research (see fig. 3).

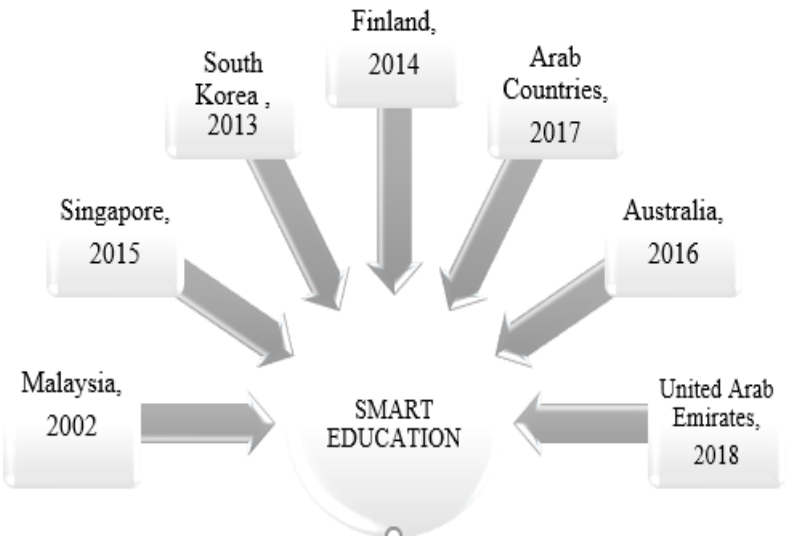

Fig. 3. Country with pioneering initiatives in smart education
Source: Elaborated by the authors based on the works [147]

Although Smart Education brings numerous benefits, it is not without challenges. First, access to technology can represent a significant barrier for less developed regions, where digital infrastructure is not sufficiently well-developed. Furthermore, the effective implementation of new technologies requires a continuous process of teacher training, as educators must quickly adapt to innovative teaching tools and methods. Additionally, the shift to digital learning raises concerns related to data security and privacy protection, essential aspects that must be carefully managed in the context of an increasingly digitalized education system.

To support the growth and development of Smart Education, it is crucial to minimize these risks. In this regard, developing a clear national strategy for the development of Smart Education becomes an urgent necessity. International strategies in the field of educational system digitalization have demonstrated the significant impact of an integrated and coherent vision, emphasizing the importance of a national strategic framework for the digitalization of education.

To build a successful "digitized learning system," national government leaders must adopt a comprehensive approach, structured around three main pillars:

1) A renewed focus on transformative teaching and learning, enabled by technology, to foster innovation and adaptability in educational processes.
2) Building a robust digital infrastructure that supports accessible and flexible smart education.
3) Ensuring forward-looking political and governance initiatives that support the long-term sustainability of educational digitalization.

The framework below outlines the core elements of each supporting point (fig. 4) [16]:

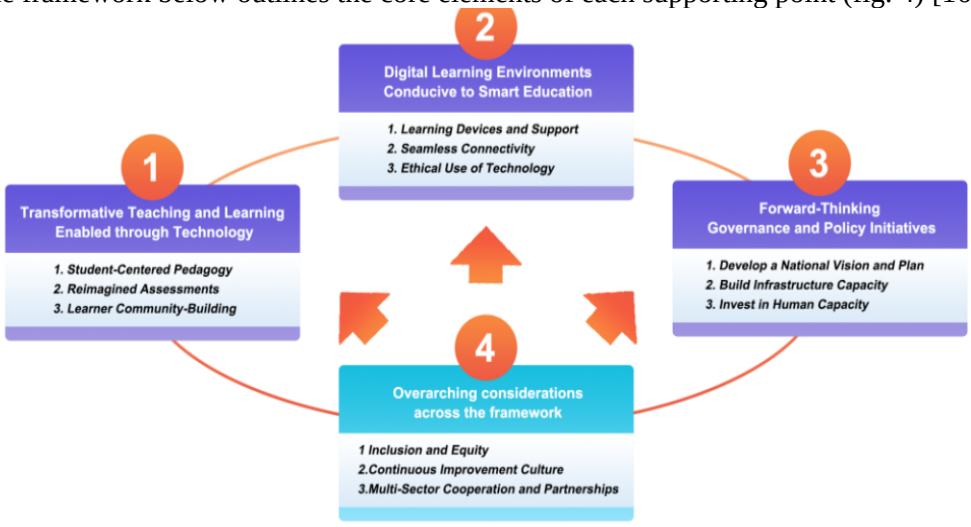

Fig. 4. National Smart Education Framework
Source: [16]

These directions will contribute to strengthening an educational system adapted to the needs of the 21st century, one that responds to the challenges and opportunities brought by the digital revolution.

4. Analysis of platforms used at ASEM

The transition towards digitalizing the educational process by adopting educational platforms (Moodle) in most universities in the Republic of Moldova has been an important step towards modernizing education and aligning it with international standards. This shift has allowed for improved access to education, streamlined learning processes, and the creation of a more interactive and collaborative educational environment.

In the paper "Digital Transformation in Higher Education" (Jones et al., 2021) [18]. It is argued that digital platforms contribute to increasing the accessibility and flexibility of the educational process. Specifically, Moodle has been recognized for its ability to integrate diverse resources and support collaborative learning.

The implementation of the Moodle system began in 2005, initially used by the faculties of Cybernetics, Statistics and Economic Informatics (CSIE), and Business Administration (BAA). In 2009, ASEM expanded the infrastructure by launching a portal (ASEM VLE) and the widespread use of email accounts (later based on Microsoft 365), aimed at informing users about educational technologies. In 2010, ASEM started designing the Anti-Plagiarism system, which was tested in 2011 for the defense of theses at the CSIE faculty. Since 2012, this system has been used to evaluate the work of all graduates at ASEM. System updates are carried out annually, based on user feedback. [1].

As a starting point, the project - module Anti-Plagiarism CROT, the only available at the time, was used [19]
Over the years, the VLE-Moodle platform at ASEM has included several anti-plagiarism systems to ensure academic integrity and originality of student work. These are:

- Sistemantiplagiat.ro - A widely used originality verification service in educational institutions in Romania and the Republic of Moldova. It helps detect plagiarism by comparing documents with a vast database.
- Plagiarism Detector - An efficient tool that analyzes and compares documents with various online sources and databases to detect plagiarism.
- Internally Developed Software - A temporary system without a commercial license, created by the institution's technical team to supplement originality checks. Typically, such systems have limited functionalities compared to commercial ones but are useful for an initial check of documents.

Another important aspect of ASEM's IT infrastructure is the identification and authentication system, first implemented in 2012. This system aims to integrate a Single Sign-On (SSO) concept within ASEM's IT system, facilitating connectivity to the EDUGAIN [1], network, an international federation for academic identity. In 2015, ASEM successfully connected to EDUGAIN, thus enhancing interoperability with other educational and research institutions [20].

The structure of ASEM's Information System (SI), presented by Sclifos C. in the work "Data Integration in the University Information System," [21]is depicted in Fig.5.

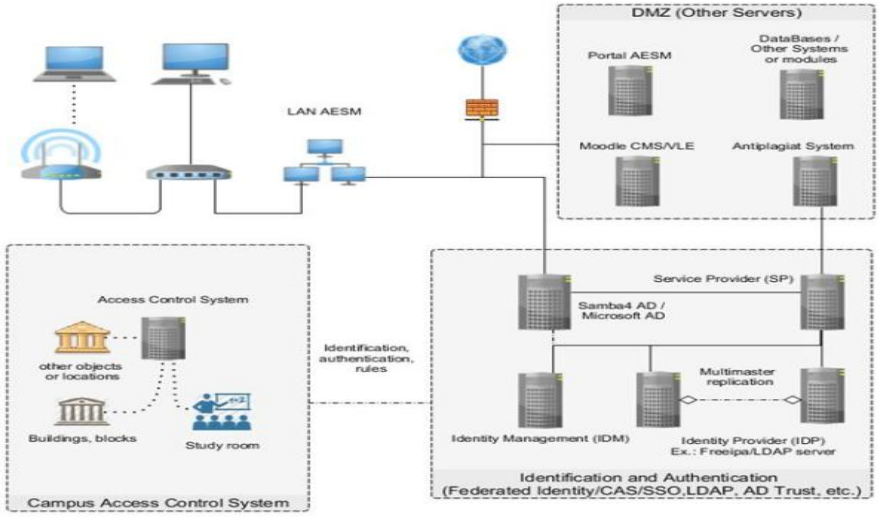

Fig. 5. Model of information systems (IS) used in ASEM
Source: [21]

The SI ASEM model was modified at the identification block, expanding the infrastructure through the launch of the ASEM VLE portal (Fig. 6).

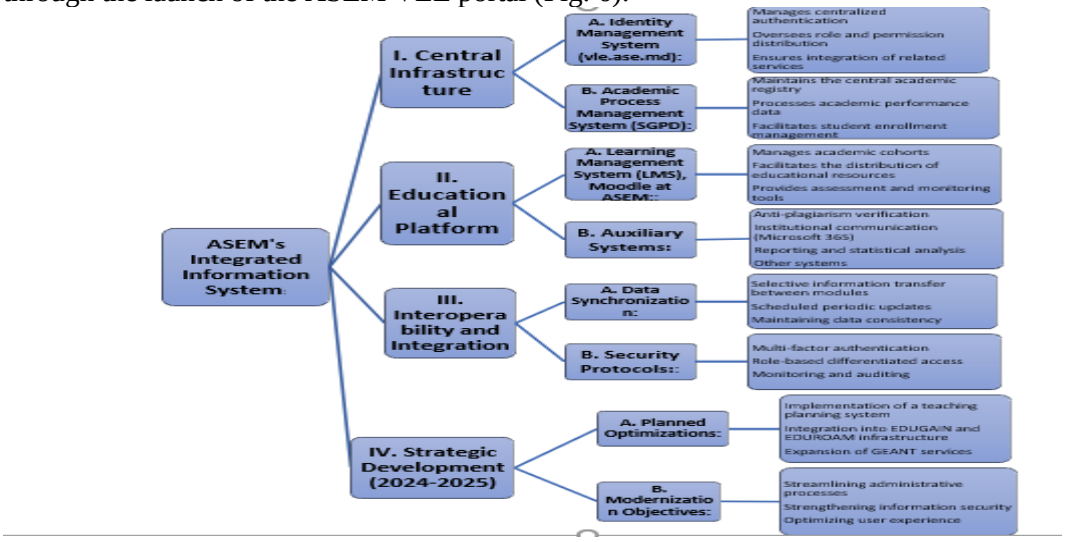

Fig. 6. ASEM Integrated Information System.
Source: Elaborated by authors according to [20]

At ASEM, the digitalization process has been accelerated in recent years through the implementation of the Moodle and VLE.ASEM platforms, leading to the modernization of teaching and administrative processes.

VLE (Virtual Learning Environment) is a term referring to an Information System used to facilitate online or hybrid learning by providing educational resources, learning activities, and an interactive virtual environment for students and teachers.

The structure of a Virtual Learning Environment (VLE) consists of several interconnected components that allow the management and facilitation of the educational process in a virtual environment. While each educational institution can customize a VLE, the basic structure includes several key modules and functionalities that support online learning.

In the context of ASEM, VLE, with its complex modular digital infrastructure, is an integrated platform that includes various tools for learning, communication, and administration of the educational process, designed for the efficient management of the educational process.

Having such a modular architecture allows for easier interoperability of components, while ensuring the functional autonomy of each subsystem. Through the Didactic Process Management System (SGPD), which is access-restricted, all grading-related information is managed.

Another module related to the allocation of class hours is currently in the testing phase. The development of the Document Circulation System (SCD) through the implementation of the 1C software, specialized in automating administrative processes and managing documents in the allocation of class hours, can bring multiple benefits and improvements within the Academy of Economic Studies of Moldova (ASEM). The connection of this module to Edugain and Eduroam is being modified. The completion of these works is planned for this year, and in 2025 the expansion of services offered through the GEANT [22] project is anticipated.

ASEM and VLE Structure

In the case of ASEM and other institutions utilizing VLE, the structure includes the following components [2, 8]:

1) User Interface (UI)
   - Homepage: Here, users (students and teachers) log into the platform and access various educational resources and activities.
   - User Profile: Each user (student, teacher, administrator) has a profile that includes personal information, activities, and educational progress.

2) Course Modules
   - Online Courses: Courses are organized into modules or sections, each representing a learning unit. Each course can include resources such as PDF files, presentations, video lessons, documents, and external links.
   - Units and Lessons: Each course can be divided into units or lessons containing specific study topics and activities.

3) Interactive Learning Features
   - Forums and Discussions: Students and teachers can communicate through forums to discuss course topics, ask questions, or share ideas.
   - Work Groups: Students can work in groups to collaborate on projects or tasks, with access to group resources and the ability to discuss.
   - Interactive Activities: These can include tests, quizzes, educational games, online assessments, and feedback sessions.

4) Assessment Tools
   - Tests and Quizzes: Teachers can create tests with multiple-choice, true/false, or open-ended questions, which can be graded automatically or manually.
   - Evaluations and Feedback: Students receive evaluations for their activities and feedback from teachers, usually integrated into a grading system.

5) Course and Account Management
   - Course Administration: Teachers can create, edit, and manage courses. They can organize educational content, manage participants, and set access rules.
   - User Management: Platform administrators can create accounts for students and teachers, manage their permissions, and monitor platform activity.

6) Educational Resources
   - Libraries and Study Materials: VLE can integrate additional educational resources, such as e-books, academic articles, and multimedia resources, accessible to students.
   - Shared Documents: Students can upload files, projects, and assignments, and teachers can distribute educational documents and materials.

7) Progress Tracking
   - Activity Logs: Teachers and administrators can track student progress through detailed activity reports (time spent on the platform, activities completed, etc.).
   - Activity Planning: Calendars and task lists help plan lessons and academic activities.

8) Integration with Other Systems
   - External System Integration: VLE can be connected with other educational platforms or management systems, such as the "e-management" system, to create a more integrated and unified educational experience.
   - Moodle: For example, if VLE includes Moodle, it can be used to organize and distribute learning materials, create online exams, and monitor student progress.

9) Communication Tools
   - Internal Messaging: Messaging system for direct communication between students, teachers, and administrators.
   - Meetings and Video Conferencing: Integration with video conferencing platforms (e.g., Zoom, Teams) for real-time online classes.

10) Support and Training
   - Technical Support: VLE provides technical support to users for access or functionality issues.
   - Tutorials and Guides: Educational resources for students and teachers, helping them learn how to use the platform and maximize its functionalities.

In conclusion, the structure of VLE-Moodle at ASEM is designed to support online learning by integrating various functionalities. These contribute to creating a complex virtual educational environment that supports both autonomous and collaborative learning. The digital transformation of education at ASEM is a relevant example of adapting to modern requirements for creating a virtual environment. Although the process has been successfully implemented, there are areas that require ongoing improvements.

5. Conclusions

Digital transformation is a sure path towards creating a complex and innovative virtual educational environment, paving the way for a more secure and adaptable future. By integrating modern technologies, higher education institutions like ASEM can provide

students with top-notch educational resources and experiences, efficiently preparing them for global challenges and enabling them to excel in their future careers. The ASEM case study demonstrates how integrating modern technologies into the learning process can support both autonomous and collaborative learning. This approach not only improves the quality of education but also increases the competitiveness of higher education institutions, preparing students for the challenges of an increasingly digitalized society.

Digitalization in education brings numerous benefits, including increased accessibility, reduced administrative time, and greater learning flexibility. However, this process also faces challenges such as unequal access to the internet, the need for continuous teacher training, and the overburdening of IT resources. To maximize benefits and overcome obstacles, it is recommended to continue investing in IT infrastructure, organize periodic training courses for teachers, and develop strategies to reduce the digital divide among students. These measures will contribute to creating a modern, inclusive, and efficient educational environment, ready to meet the needs of an evolving society. Smart education is „facilitating skills and learning to enhance the competitiveness of the municipality through increased support of local talents."

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