Intelligent parametric educational web platform system design

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Abstract

The new generation does not accept traditional teaching methods. However, at the same time, today's young people are informationally and technologically aware and strive for a new approach to acquiring knowledge and skills. In addition, the modern educational space has many global issues and challenges, including the pandemic and problems with access to electricity and networks, which are connected to distance learning becoming increasingly relevant. Today, intelligent educational platforms partially solve these issues and can meet the needs of students; at the same time, they do not fully cover the full range of modern requirements and technical capabilities for the educational process. The presented innovative educational platform has absorbed the main technological innovations, namely intelligent systems built on processing large amounts of data, which are the main component, along with algorithms and artificial intelligence systems. The presented concept of understanding the educational platform is based on the practical experience of teaching and preparing trained courses for students of higher education institutions of various specialities. The presented system is based on the interaction of the teacher and the student and them with the intelligent system separately. This allows all participants in the educational process – students and teachers – access the learning platform 24/7. In addition, thanks to modern concepts of software architecture and the paradigm of human interaction with the machine interface, the presented system provides an opportunity to work and dynamically change parameters by a teacher who does not have the appropriate technological knowledge or is not a professional software developer. The educational platform is part of a more global e-learning system and a new paradigm of modern education.

Keywords

digital education, smart data, web service, educational technologies, systems design, data-driven systems

1. Introduction

Undoubtedly, educational technologies are essential and much-needed elements of the modern educational environment. Teachers and students have many tools and services in modern education. Many software services, such as Massive Online Open course software, can help conduct offline or online classes and create unique educational platforms. Many helper services are available for students, from proofreading to digital design to personal assistance.

Existing educational services primarily provide online video lectures, special automated or semi-automated graded assignments, and course/degree completion certificates. From the technological side of things, existing MOOC platforms, educational hubs, and software toolsets, for the most part, provide the black-box environment with limited to no customization options or require special software development skills that many teachers and professors do not possess.

In this paper, we study existing states of available and used online/digital educational environments and provide a new view on how these systems can be enhanced or modified, developed from the ground up to be useful and usable by academic staff and students alike. The research aims to build a foundation for future educational software systems that can be standalone or connected to existing educational platforms, focusing on personalized content and the ability to customize educational content easily. Within the scope of the present research, we referenced existing educational methodologies, approaches, and state-of-art technologies.

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Besides, modern software and systems design paradigms have been referred to when creating a system platform concept. The research work is limited in scope and aims to highlight general platform sections and use case scenarios, regardless of study subject or degree, while maintaining an open-minded view of how the education process will look soon.

The presented educational platform concept is not entirely new, and there have been several similar research and practical works in the past. For this reason, we considered using AI-related technologies to gather with data-driven design to present a unique and novel view of how the educational process can occur with the new system. The researchers note that developing a close partnership between interested parties, such as artificial intelligence developers, teachers, and researchers, is necessary to use artificial intelligence technologies in education and training effectively. They propose to support such a partnership through the EDUCATE Educational Technology (EdTech) program [1]. In their research, the authors focus on new artificial intelligence methods, including knowledge presentation tools, allowing students to regulate the sequence of learning educational components according to their own needs [2].

A conceptual and systemic framework for the development of adaptive, dynamic, intelligent learning (SMIT) systems is formed, which aims to integrate LMS and ITS to improve the MOOC system and various design options for smart MOOCs and the use of AI tools for education are presented [3, 4]. Of course, intelligent educational systems have been a hot research topic covered by several prominent study groups [5, 6, 7]. However, not all consider the larger picture or look at the process from only one viewpoint – educational or technological.

The study's authors expand the current architecture framework by proposing a scalable mathematical model for system architectures that is scalable and supports the joint evolution of various aspects, including AI systems [8]. Ways to improve the conversational user interface based on a chatbot to improve interaction with an educational institution's website and provide users with effective information have been actively considered [9].

Among the potential constructs and approaches that can lead to a comprehensive understanding of intelligent learning environments, the researchers single out the cognitive model of innovative learning and the model of the level of intelligence, which they believe will be able to realize the current challenges of standardization in the field of learning, education and professional training, by creating a platform for new standards in the field of education [6, 7].

Real-time communication and active usage of chatbots or smart commutation platforms are new trends in software design and digital educational technologies. Researchers point out that the logic of capitalization, attention, or governance in Google, Facebook, or Twitter does not always coincide with the logic and work operations typical of digital education platforms. Instead, a significant number of digital educational platforms work according to different business models. The authors investigated the role of educational platforms as an innovative element of communication between schools and families and suggested ways to improve it.

The article presents new short-term and long-term perspectives for improving assessment systems to support teaching and learning [10, 11, 12]. The concept of personalized content and recommendation systems, knowledge, and other "smart" technologies have been talked about and researched for quite some time [11, 12, 13].

Its active usage and implementation in modern education is a new concept.

2. Research methods and materials

For the research materials, the data and personal educational experience were used. We referenced data and based the study on several educational courses and bachelor's degrees. Table 1 reveals the hidden data that we relied on in the study in the context of the experience of teaching and preparing educational materials, creating online courses, conducting assessments, communicating, and recording student progress. The results of the teaching courses in three different specialities, Cybersecurity, Food Technology, and Animal Science, were analyzed to conduct the study. These courses are taught

Table 1
Educational courses data.

Course name	Courses Data	Students Assessment Data
Systems Development 2, Bachelor of Science in Cyber Security	56 students 3rd year Exam and Final Project	Median mark – 78 Average mark – 80
Material Science, Bachelor of Science in Food Technology	76 students 2nd year Test	Median mark – 76 Average mark – 81
Biochemistry in Animal Husbandry, Bachelor of Animal Science	81 students 2nd year Exam	Median mark - 71 Average mark - 74

for undergraduate and 3rd-year students. Each of the courses has a significant number of students, respectively: 56, 76, and 81. The success of students' studies in each of the courses is analyzed. Thus, the highest grades (76 and 81) have students who studied "Materials Science", and the lowest (71 and 74) in the discipline "Biochemistry in Animal Husbandry".

Massive online open educational platforms are actively used in modern university environments and private educational institutions. In our study, we referred to the popular MOOC platform – Moodle and its implementation- E-Learn platform. List of educational and assistant services provided by the E-Learn platform:

- **individual course page** – lectures, assignments, and multimedia content (created by the lecturer);
- **individual student page** – attendance data, course assessment results data, individual student profile;
- **assessment system section** – individual work, educational module, cumulative mark, particular exam, and test assessment.

The E-Learn platform is a modern digital tool for teachers and students. With its help, it is easy for the teacher to organize the educational process for students remotely from anywhere in the world and at any time convenient for the student.

The teacher personally fills this platform with educational materials for each course, places the syllabus and the entire course program, uploads notes and presentations of lectures, tasks for laboratory and practical work, and students' independent work. Also, each lecturer places tasks on the course to control students' knowledge: schedules for the delivery of each work and control measures, tests, modular tests, and exam tasks. If necessary, the e-learning course may contain additional materials like video films, instructions, etc.

With the help of the E-Learn e-learning portal, a student can take each training course online, constantly have feedback from the teacher, see their progress, and be able to score points for the exam and increase their educational rating. Moreover, because of studying the course, have objective transparent information about individual educational achievements (figure 1).

In addition to MOOC platforms, both students and academy staff use a wide range of software and mobile applications. A list of the most commonly used tools, as well as their typical usage examples and specific services, is provided in table 2. This data is helpful and useful to understand better typical educational use case scenarios and patterns, which in turn are used to design and construct new software educational platforms.

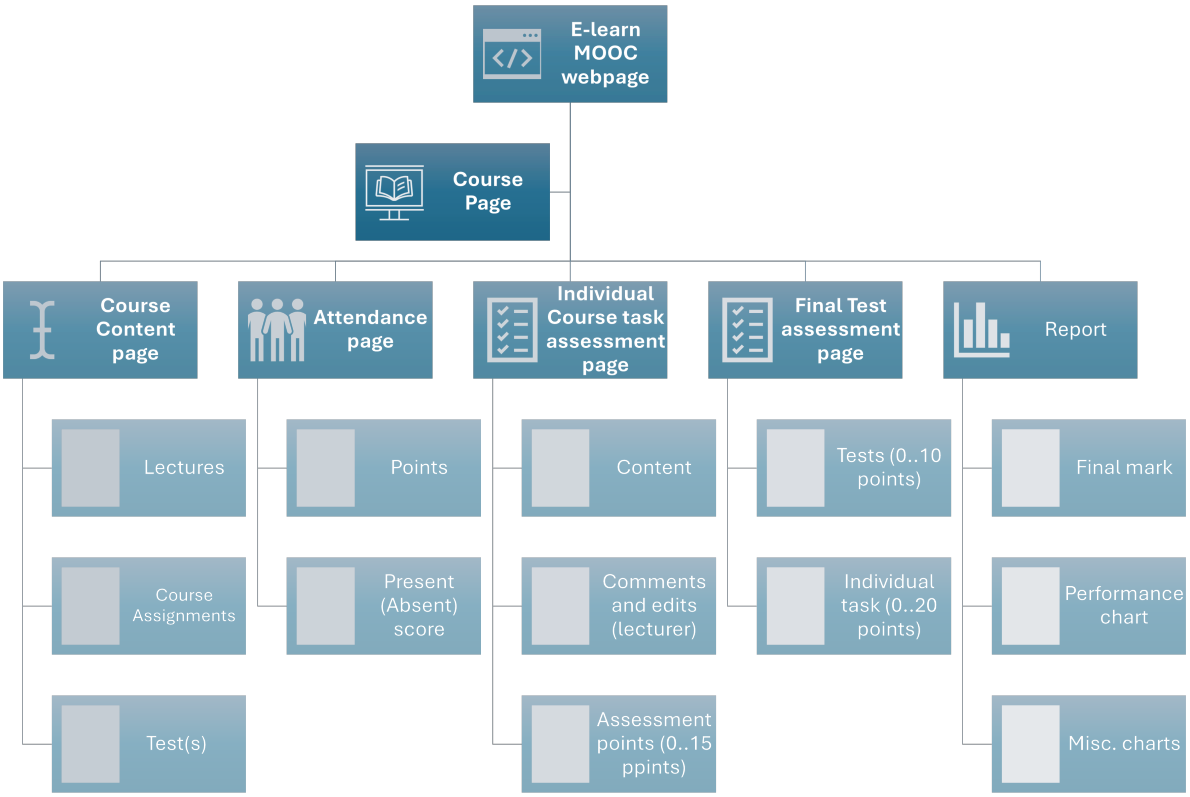

Figure 1: Digital MOOC E-Learn platform sample course pages.

3. Results and discussion

The educational process revolves around sharing knowledge and the assessment process. Each teacher prepares his own author's training course in the discipline provided for by the curriculum of the relevant speciality, which is then independently posted on the educational portal. The teacher divides the training course into several modules.

In general, the training course contains the following components: lectures in the form of test documents and presentations, methodological recommendations for students to perform laboratory and practical classes, materials for independent work of students on each topic of the course, recommended literature, test tasks to control students' knowledge and examination tasks. The teacher can supplement his course with other materials, videos, etc.

Students use all these materials during the course. Apart from educational content, the education process and digital platforms to support it should include data-related systems and a knowledge base that is accessible in real time. The conceptual representation of such a system is presented in Figure 2. While the new digital Web educational platform model denotes a high functional level, the main action loop in any online education system is course creation and student–teacher-platform interaction. Figure 3 demonstrates the typical main action educational process flow within the context of the educational system.

New digital web educational platform requirements: connectivity to open online resources and search engines; simple and easy-to-understand User Interface for non-IT professionals; large files and multimedia upload support; improved interactivity and individual/group communication with student-lecturer; system customization and API connectivity for educational IT-admin personnel; extensibility and AI-powered toolset support; ability to integrate existing course materials and new software, toolset into educational process and others. Pros and cons of existing educational platforms and methodologies:

- **advantages**: ease of use of modern educational platforms, accessibility, free of charge, quick search, and viewing of the necessary educational materials;

Table 2
Educational technologies and tools classification.

Toolset type	Example Application	Usage Scenario
Online educational platform	Moodle Blackboard Google Classroom Canvas LMS	Creating a Course and Uploading Materials Conducting classes Checking Student Progress
Text and Content Generative Software/Services	ChatGPT MS Copilot Claude Grammarly Midjourney Adobe Firefly Dall-E 2	Writing and proofreading Creating charts and images for a course or lab Writing reports by students on the work done and answering questions
Remote communication services	Zoom Webex Google Meet WhatsApp Misc. Online messaging and communication Services	Conducting online lectures and practical classes Online communication and counseling (teacher - group of students, student) Individual counseling of students and reception of completed tasks, assignments, presentations
Online Educational Services	Coursera Khan Academy EdX Udemy Udacity	Search for a variety of materials when preparing the course Search for additional learning materials Extracurricular Individual Counseling Training
Work tools and service	PC, laptop, smartphone, camera MS Word, Google Docs Paint, GIMP Pen and paper	Preparation of educational materials Creating Lab Assignments Performance of assignments by students Current work and recording of lecture notes and classroom practice

- **disadvantages**: the ability to use only one resource locally (one platform), the limited ability to fill with electronic materials; subjectivity in the assessment of students, manual verification of works and assignments, there is no way to check the test of the student's assignment for signs of plagiarism.

The educational process centres around close interaction and communication between students and teachers. With the help of software tools, this process can be enchased and provided, simplify students' day-to-day labour tasks, give access to new technologies, and make the course presentation like other digital interactions students engage in (engage) in their daily lives. The interaction cycles between teacher and students revolve around the coursework, and intelligent support systems help make this interaction more flexible, provide a broader range of options for both parties and enhance course presentation.

The lecturer's goal is to present new study materials, while the student wants to learn/master a new skill, the course page serves as a place for interaction and main material narration; the intelligent system is optional in this interaction loop, but it serves an important role to help facilitate the educational experience for everyone involved (figure 4).

From a software modelling and architecture viewpoint, applications should have special user roles

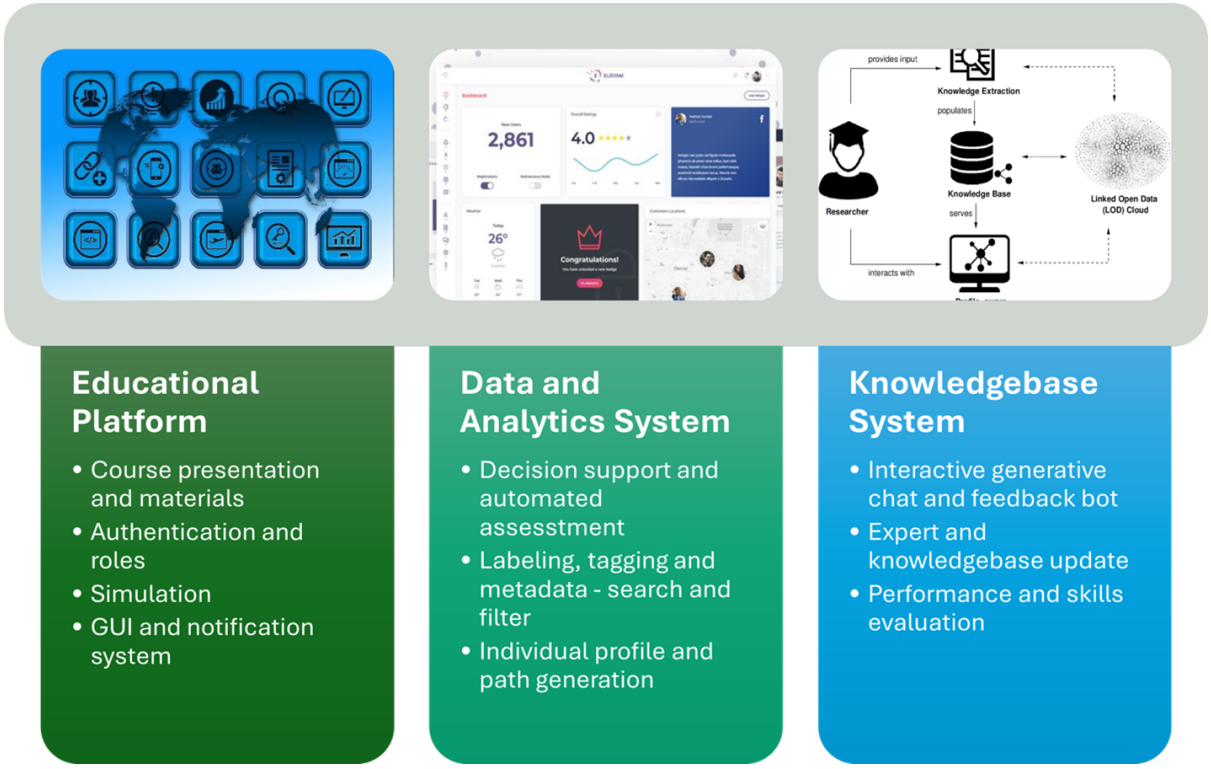

Figure 2: New digital web educational platform concept.

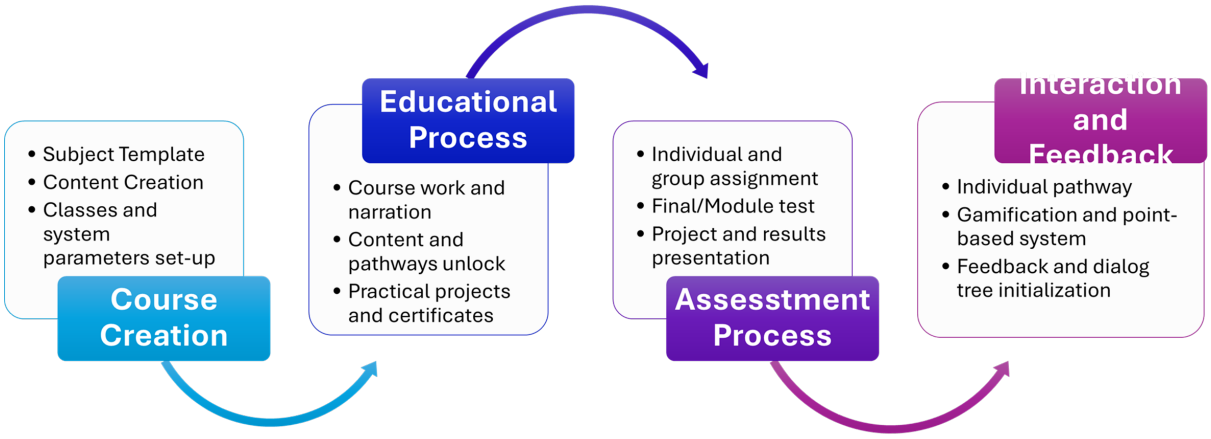

Figure 3: Web educational platform process flow.

and appropriate access credentials. In addition to the standard roles introduced above, such as student and teacher, there are teaching assistants, deans, department heads, and miscellaneous university staff (stakeholders). Each of these users can access the main application, but what systems they will be able to access and whether they can modify it depends on their role. The most prominent systems are course pages, student profiles, professor course and student's dashboard, course content, and other materials (figure 5).

The system processes each new command or input and places them in the tasks queue systems; at the high abstraction layer, these tasks can be classified and grouped based on their platform-related and educational process tasks (assessment, reports, assistance, etc.). While educational platforms are very complex and multilayered systems, the Smart Data sub-system is considered key/unique (bottom diagram in figure 5). The data sub-system is accessed via main application calls; simultaneously, it

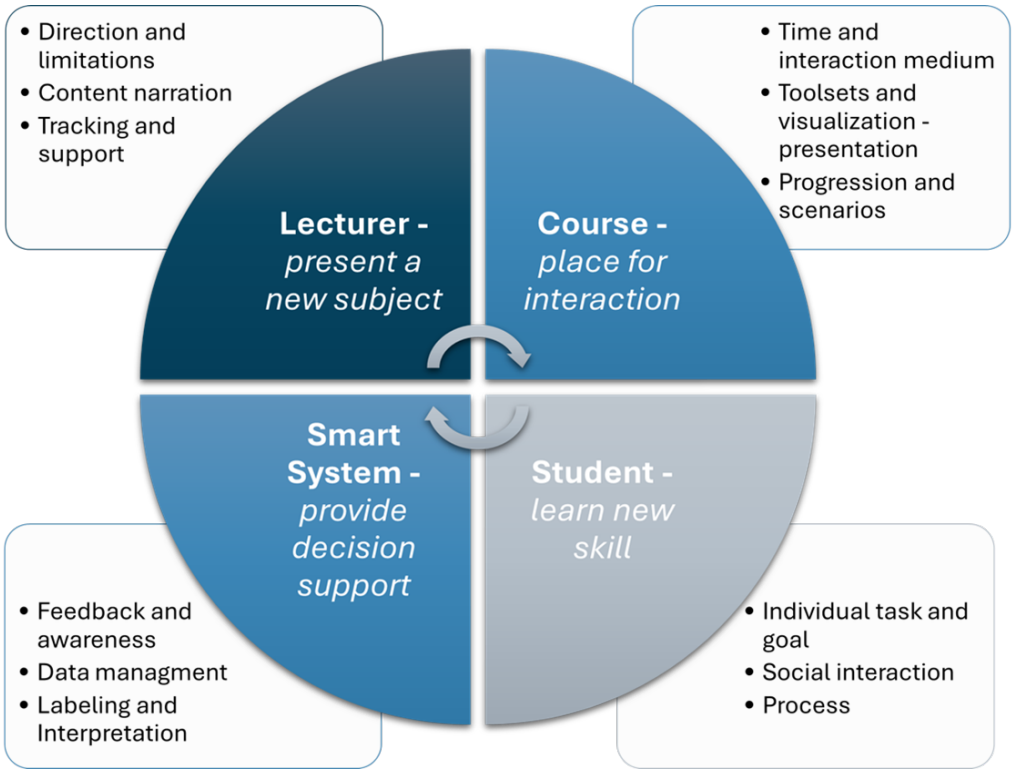

Figure 4: Student and lecturer web-platform interaction process and user experience.

is always operational – gathering data, processing, and constructing data models for future usage. This system comprises several prominent special software modules – expert, learning, knowledge, and historical-processing.

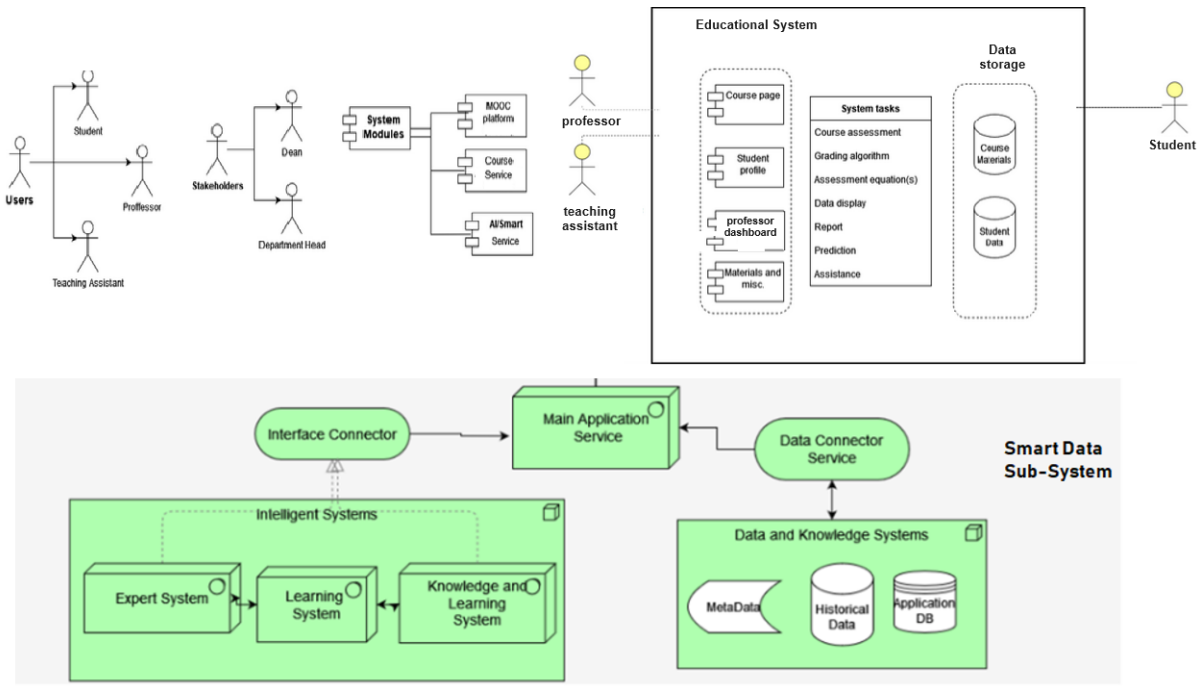

Figure 5: Educational web-platform system, user roles and modules.

The presented educational intelligent system platform consists of several underlying complex software modules and functional systems (figure 6). The upper (presentation) layer centres around Web

Table 3
Educational Platform Data Types and Sources Classification

System	Data	Source	Representation
Direct interaction	Physical input/output Virtual input/output Analog/Digital signal Visual/Sound	Physical Devices Screens Sensors	UI elements: notifications; sound; music; haptic; feedback: spatial effects; misc.
Educational application	Main Application Realtime data User data Temp data	- User input - SQL/NoSQL - Tables - Programming Code	Personalization Content and User Data Web UI
Visualization and communications	Objects Multimedia Content Packets and protocol data	- System i/o - Graph tables - Binary content - Chatbot and conversion data	Modeling and Visualization Realtime communication Course Content
Knowledgebase module	Model data Patters Personalization content	- Historical data - Training models - Platform data input and output	Data – model, evaluation, preparation, optimization
Internal processing core and algorithms	Algorithms data Metadata Descriptors and tags	Main smart routing, processing and assessment algorithms, and processing logic	Patterns System level variables Dynamic balancing, service management and routing

Applications that students and teachers access. The application can be accessed using private user credentials, and the user interface changes based on the user roles (in the future, it can adapt and be altered in real-time based on user-system interaction). At the heart of the system is the central processing system module that processes incoming and outgoing requests and connects to other/existing applications and modules.

Besides, course-unique content is generated within the processing layer, and unique intelligent systems are enabled/set up. Data, including system customisation parameters and variables, is stored and processed in the bottom layer. A wide array of underlying educational platform systems can be categorized into three sections – automated processing systems, unique platform-related systems, and assistant (helper) systems. Each section consists of several applications or modules, outlined in the bottom section of figure 6.

4. Conclusions

Modern times require a new view of how the educational process flows and how it should adapt to new challenges and technological breakthroughs. An increase in wired and wireless network coverage, internet connection speed (for example, 4G, 5G, Wi-Fi, etc.), and massive availability of relative chapeau computational devices, such as mobile phones and laptops/tablets, open new opportunities for the educational process. New open software platforms like NLP, DL, LLM, and others allow for more personalized and adaptable software systems and platform design.

The presented educational smart systems platform considers AI-related technologies and digital communication and personalization paradigms. This data-driven platform relies on the course materials and content to function fully. It is focused on personal customization options and provides appropriate

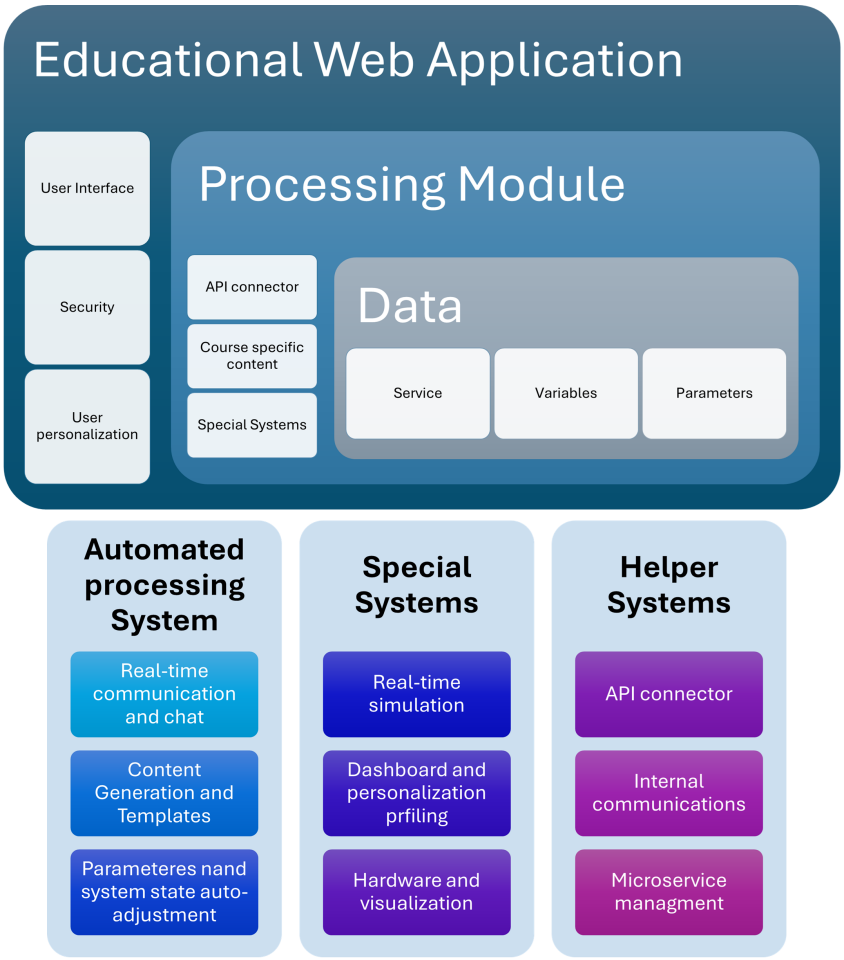

Figure 6: Educational smart system platform operation algorithm.

tools for the teachers and professors to help them prepare study materials. Another critical aspect of intelligent systems is gamification and special services for students, which will help them keep track of their progress and receive educational support in real-time. In the future, we plan to expand the concept of this system further and introduce more smart-related technologies, together with particular simulation and lab-work visualization, for enhanced study experience.

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