



# **DIPLOMA THESIS**

Indikativní srovnání výukových programů na univerzitách ve Spojených státech a v České republice na konkrétním příkladě

Indicative Comparison of Educational Programs at Universities in the United States and the Czech Republic on a Concrete Example

**STUDY PROGRAM**  
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**Indicative Comparison of Educational Programs at Universities in the United States and the Czech Republic on a Concrete Example**

Pokyny pro vypracování:

Cílem práce je přispět ke zkvalitnění vysokoškolské výuky na příkladu amerických univerzit s tím, že se DP za měří na problematiku distanční výuky konkrétního studijního programu. Práce bude rozdělena do tří částí: První teoretická část se zaměří na teoretická východiska měření kvality vysokých škol a na aktuální statistiky, vysvětlí základní principy, výhody a rizika vysokoškolské distanční výuky a podstatu webovských aplikací distanční výuky ve světě. Druhá metodická pojmenuje srovnávané university a jejich studijní programy, vybere konkrétní program v České republice a stanoví zadávací specifikaci webovské aplikace. Třetí praktická část vytvoří a nastaví výchozí verzi webovské aplikace vybraného předmětu v anglickém jazyce, představí a obhájí její funkce ve srovnání s jinými aplikacemi, užívanými ČVUT. Práce bude zpracována v anglickém jazyce.

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## **Gratitude**

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## **Abstract:**

The aim of the thesis is to contribute to the improvement of university teaching on the example of American universities, focusing on the issue of distance learning of a particular study program. The thesis will be divided into three parts: The first theoretical part will focus on the theoretical bases of measuring the quality of universities and their level of teaching, on current statistics, explaining the basic principles, advantages and risks of university distance learning and the essence of web applications of distance learning in the world. The second methodological part names the compared universities and their study programs, selects a specific study program at CTU and sets out the specification of the web application. The third practical part will create and set the default version of the web application of the selected subject in English, introduce and defend its functions in comparison with other applications used by CTU. The work will be processed in English.

## **Keywords:**

Education, Learning Management System, Innovation, Application.

## **Abstrakt:**

Cílem práce je přispět ke zkvalitnění vysokoškolské výuky na příkladu amerických univerzit s tím, že se DP zaměřuje na problematiku distanční výuky konkrétního studijního programu. Práce bude rozdělena do tří částí: První teoretická část se zaměří na teoretická východiska měření kvality vysokých škol a na aktuální statistiky, vysvětlí základní principy, výhody a rizika vysokoškolské distanční výuky a podstatu webovských aplikací distanční výuky ve světě. Druhá metodická pojmenuje srovnávané university a jejich studijní programy, vybere konkrétní program v České republice a stanoví zadávací specifikaci webovské aplikace. Třetí praktická část vytvoří a nastaví výchozí verzi webovské aplikace vybraného předmětu v anglickém jazyce, představí a obhájí její funkce ve srovnání s jinými aplikacemi, užívanými ČVUT. Práce bude zpracována v anglickém jazyce.

## **Klicova slova:**

Vzdělání, systém řízení vzdělávání, inovace, aplikace.

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# 1. Introduction

The significance of education in contemporary society is immeasurable as this process is essential for both individual and national development. Obtaining a higher education or completing certain courses is no longer sufficient; the application of acquired knowledge is crucial for social and economic progress.

The curriculum of educational programs shapes the content of education. This content must foster harmony and collaboration between individuals and nations, regardless of their racial, national, ethnic, religious, or social backgrounds. It should also acknowledge the diversity of worldviews, facilitate students' freedom of thought and belief, encourage personal growth, and align with spiritually and morally accepted values within their family and community. Moreover, the vocational education and training curriculum should provide the necessary skills and qualifications for the workforce.

Contemporary scholars have observed the emergence of a distinctive decentralized model for higher education management in both the United States and the Czech Republic. This system incorporates extensive institutional autonomy for universities, the absence of a centralized administrative or methodological framework guiding their operations, and active involvement from public and professional organizations and associations in shaping the scope and substance of individual courses and educational programs. These entities also play a critical role in crafting recommendations and qualification criteria for graduates and overseeing the standard and caliber of educational provisions.

Contemporary pedagogical practices are guided by prevailing educational standards, which dictate the creation and adoption of efficacious forms and techniques of instruction. These include the distance mode of learning, business simulations, role-playing games, training sessions, and the like. These innovative methods aim to enhance the effectiveness of educational provision by facilitating a more engaging and interactive learning experience.

In order to modernize higher education, novel approaches centered on individualized learning must be explored. This entails the establishment of optimal pedagogical conditions that foster the cultivation of pertinent competencies in graduates of higher education institutions. The integration of competencies into educational programs serves to pivot the pedagogical process towards the nurturing of student personality, as an active and inventive agent of professional activity. Of paramount significance is the identification of a definitive set of competencies that will shape the focus of the educational process in higher education institutions, thereby determining whether it will be subject-centered or personality-centered.

The significance of this study is rooted in the dearth of comparative analyses of educational systems abroad, despite the wealth of information available on this subject. To date, such analyses have been limited to broad and general issues found in pedagogical textbooks and online resources. Furthermore, the attitudes of professionals towards the potential of

utilizing distance learning technologies.

The educational systems of the United States and the Czech Republic are the object of the study. The subject of the study is a comparative analysis of the educational systems of Kansas State University and CTU MIAS. The aim of the study is to develop a web application for the organization of online education, which contributes to improving the quality of educational services in the university.

Research methodology. When writing the work the following general scientific methods of research were used: analysis of literary sources, analogy, comparison, observation; and specially scientific methods of socio-humanitarian sciences: structural-functional, systematic.

The theoretical import of this research lies in its comprehensive and systematic analysis of the matter of assessing and administering the quality of educational services dispensed by tertiary educational institutions, as well as in its justification of enhancing the standard of the educational process by means of distance learning technologies.

The practical significance of this research rests in the fact that the findings and the web application that was created to facilitate online education and enhance the quality of educational services in the university can be utilized by educators in other tertiary educational institutions.

# **Theoretical part**

## **2. Enhancing Education Quality and Innovations in Modern Educational Institutions**

### **2.1 Quality of education - the key idea for the development of modern educational organization of universities**

Quality of education is an important aspect of higher education and plays a key role in the development and retention of institutions worldwide. Maintaining a high level of quality is essential for today's higher education institutions to remain competitive, especially in an increasingly globalized higher education environment. Quality in education covers a wide range of activities, such as curriculum development, teaching and learning methods, student support services and research activities. Quality assurance helps institutions to identify weaknesses and implement strategies to address them, leading to continuous improvement in teaching practices. In addition, quality assurance plays an important role in ensuring that graduates are properly prepared for the world of work and provides students with the skills and competencies needed for successful careers (Bernhard, 2018).

The concept of quality education plays an important role in the development of modern educational organizations. Quality education is defined as education that is relevant, equitable, inclusive, and responsive to students' needs for knowledge acquisition, skill development, and personal growth. In other words, quality education ensures that students receive an education that prepares them for success in their careers and lives.

In recent years, the concept of quality education has received increasing attention and has become an integral part of the development and content of educational institutions worldwide. It is no longer enough for educational institutions to focus only on academic content; they must also prioritize the development of social skills such as communication, teamwork, and critical thinking. This is because employers are increasingly looking for candidates with a wide range of skills and competencies, not just academic knowledge.

The concept of quality education has also led to a shift in emphasis from teaching to learning. Institutions are no longer just providing information to students, but focusing on creating an environment that promotes active learning and encourages students to take responsibility for their own learning. This approach has been proven to increase student engagement, promote retention, and lead to better learning outcomes.

The quality of education reflects the overall:

- The general ability of an educational organization to fulfill its functions and tasks at a certain level,
- The integrity of the quantity, structure, and implementation of the potential and resources of human, scientific, methodological, material, technological, and other

resources,

- The dynamics of the process of development of the educational organization, the improvement of all its structures as a pedagogical system (goals, rules, standards, organization, information, content, motivation, stimulation),
- The positive perception of the educational organization by society, the participants of the educational process,
- The overall role and importance of the educational organization as a socio-cultural institution for the formation of spirituality and reproduction of spiritual resources,
- Cooperation of the educational organization with cultural institutions, other educational institutions, etc.,
- Achievements of educational institutions, teachers, and students through participation in various competitions, preparation, and competitiveness of graduates,
- Development of an educational institution as a social system,
- Improvement of approaches, methods, and procedures to ensure the quality of educational processes and results.

The fact that the concept of quality in education is not only proclaimed but also actively implemented is confirmed by the measures taken by national education authorities, the growing number of studies and publications on the subject, the actual implementation of quality systems by many educational institutions, the use of quality measurements and their results to assess the quality of educational institutions and processes, participation in quality competitions for self-assessment according to relevant standards.

Specific applications of the concept of quality in education include:

1. Creation of a regulatory framework for educational activities and implementation of accreditation and validation mechanisms,
2. Implementation of a mechanism for evaluating the quality of education,
3. Development of a concept for monitoring of education quality in the center for research of professional education quality.

Despite the simplicity and certainty of the approach to improving the quality of education, this issue has not been adequately addressed. In particular, at least three problems can be singled out:

1. A set of measures is needed to develop appropriate approaches, models, and tools to regulate not only the assessment of educational outcomes, but also other aspects, components, and facets of the quality of education.
2. Pedagogy, which is oriented to the classic concepts of learning and development, cannot solve the problem of the quality of education by itself at the present time. The quality of education is an interdisciplinary problem that requires the integration of disciplines and theories, in particular pedagogy, quality research, educational systematics, pedagogical science and management theory.
3. The education sector is increasingly recognized by society as a service sector (specific services related to the formation of human personality, reproduction of intel-

lectual resources and transmission of cultural values). If education is a service, then the approach to ensuring its quality should be the same as in various sectors of activity around the world: we are talking about the adoption of TQM concepts and the basic provisions of ISO quality standards. In particular, the latter impose rather strict and specific requirements, such as quality control at all stages of service provision, management of all kinds of resources, creation of a quality system of the organization or institution and documentation of all quality management procedures.

These problems are not insurmountable. There are many reasons to believe that the modern system of public education and scientists have sufficient capacity and experience to solve them.

Another theoretical and methodological issue concerns the logic of quality systems in education. Many educational institutions have begun to implement them, but this process is often based on the formal application of ISO standards, without proper interpretation of their provisions and requirements. ISO standards describe the elements of a quality system, not how they are used in a particular organization. It must be remembered that this is not the case. The design and implementation of a quality system should be influenced by the specific goals, product types, processes, and practical experience of the organization.

In the field of learning, the following characteristics are important:

- Consumers of educational services (students) are actively involved (together with teachers) in educational activities, and the final result depends largely on their activity, attitude, motivation and efforts,
- Students' satisfaction with the quality of education is subjective and cannot be the only criterion of evaluation,
- Objective check of the quality of graduates' education is carried out outside the educational organization, according to the criteria and indicators accepted in the system of professional, higher education and the sphere of professional activity. This situation determines the importance of self-assessment, as the requirements to the system of knowledge, skills and competence management at all stages of education are becoming more and more stringent,
- The result of the educational process is a complex, intangible, renewable and individually unique product in the form of education. As mentioned above, educational organizations play a key role in shaping it, but they are not the only ones. In addition to educational organizations, families, institutions of additional education, mass media and other socializing institutions participate in the formation of education. For this reason, it is important to consider not only what factors in the educational process affect education, but also how they relate to factors and life circumstances outside the educational organization,
- Due to the requirements of humanization, individualization of learning and maximum disclosure of intellectual potential and creative abilities of students, it is impossible and impractical to fully implement a targeted program approach to learning and mastering curricula. The educational process cannot be fully technologized, nor can the "deviation management" model be applied. This means that quality improvement is always associated with a number of unresolved factors that cannot be managed to some degree,

- The role of the individual is more important than others in ensuring the quality of educational services. It cannot be ruled out that two teachers may achieve different results when teaching the same students in the same curriculum. This must be taken into account when choosing principles for building organizational structures, choosing means, forms, and strategies for administrative influence, and designing assessment and diagnostic sets.

These principles must be considered at all stages of the design and implementation of the educational institution's quality system. These principles determine the composition of the elements of this system and the nature of the relationship between them.

These key features must be taken into account at all stages of the development and implementation of the quality assurance system in the university. They should determine the composition of the elements of this system and the nature of the relationship between them.

According to ISO standards, the quality system includes not only the elements through which the quality management functions of processes and products are implemented, but also the elements through which the activities of the organization or institution are implemented and supported, as well as the elements that determine the environment that forms the quality.

The pedagogical system of quality management of internal processes of university education integrates the efforts and resources of organizational, methodological, scientific, personnel, administrative, and other resources, involving all the structures of the educational organization as a pedagogical system, to achieve high quality in activities and results. This should meet the best practices and relevant standards in design.

Solving these theoretical, methodological, and practical issues will undoubtedly contribute to the development of a powerful movement for quality education, which will largely determine the face of foreign universities in the 21st century.

## **2.2 Innovative development of education: global changes and challenges**

The innovative development of education is a subject critical in this day and age, as globalization and mechanical progressions have achieved various changes and difficulties to the field. With the rising interest for higher quality education and the need to adjust to quickly developing advances, education frameworks overall are confronting critical strain to change their practices and embrace innovative methodologies. This requires a careful comprehension of the worldwide changes and difficulties that are molding the educational scene, and a readiness to participate in continuous exploration, trial and error, and cooperation with partners to plan and carry out viable arrangements. Fruitful development in education relies upon a scope of elements, including the accessibility of proper assets, successful initiative, and a solid obligation to consistent improvement. Thusly, it is critical for policymakers, teachers, and scientists to cooperate to establish a strong climate that cultivates development, coordinated effort, and the quest for greatness in education (Fredman, 2023).

When considering general ideas about the patterns and shapes of global human develop-



ment, it is important to address the issue of determining the role of science and education in this development. In this context, we will present several initial propositions that reflect some aspects of the interplay between science, education, and socio-cultural processes:

1. Education is still significantly influenced by political and ideological factors, which often result in the adoption of false or misguided priorities and the artificial transmission of value systems. This can lead to education being isolated from socio-cultural processes.
2. The slow overcoming of educational skepticism among the political elite, which is reinforced by public attitudes and the long-term nature of investment return cycles, creates a persistent stereotype of education as an expensive and non-productive sector. This leads to various budgetary constraints, plans, and decisions to move education to fee-based models, maintain the current level of segregation in the quality of education, and so on.
3. The existing pluralism, traditionalism, and variance in the content of education, combined with its socio-driven direction and paradigmatic irregularity, significantly diminishes the impact and contribution of educational systems to the generation of intellectual and social resources for society.
4. The relationship between science and education is stochastic and does not necessarily align with social development attitudes, which prevents rapid progress in that area in accordance with real trends.

These statements don't cover all the issues related to social development in modern education. However, it can be expected that focusing on the productive goals of the issues and inconsistencies can form the reasonable core of key changes in the economy, management, standardization, and legislative education, the mindset of educational cycle members, and external relations of educational systems.

The general vision of such changes on a global, public, world, and social scale can be presented as follows:

- Global reconciliation processes in education, including the establishment of common principles, unification, addressing issues of inter-country collaboration and the integration of logical and educational potential, should not lead to the destruction of the fundamental foundations of public educational frameworks as administrative structures, the element of public and state management, paradigmatic settings, etc.
- Changes in education, in its content, should precede and form the basis for changes in different areas and circles of society. This is because the relationship between education and the economy, socio-cultural circles, etc., is individual. The quality of work, products and services, social relations, quality of life, and development processes depend on the level of its development, formed in the educational system.
- The current stage of human community development, where global trends address the issue of building the foundations of an educational society with developed elements of interpreting logical information, existing perspectives in public awareness and interest in knowledge and culture, the presence of powerful plans for continuous education, and assurances of equal access and the right to obtain it.
- It is important to further search for ways to improve the effectiveness of educational

systems, the efficiency of educational activities in terms of academic and social outcomes, and make development processes in education more reasonable and in line with global values.

The increase in labor productivity and the introduction of new advancements in the fields of production and services are directly related to the improvement of the quality of work resources worldwide. Therefore, the issues of vocational education are viewed from the perspective of the economy's modernization needs and the search for adequate responses to 21st-century challenges. Various requirements are being imposed on the labor force in current circumstances, which were not anticipated and were not set as the main ones just years ago. Such requirements include professional mobility, the ability to master new technologies, competitiveness, high quality, and intensive performance of work capabilities.

In the context of economic changes and the democratization of society, the issue of accessibility of high-quality new workforce gains special significance. This is evidenced by the practices of many countries around the world, which prioritize the resolution of issues related to professional training, retraining, and high-level personnel preparation. In the current state of production development, the role of human beings has fundamentally changed. Previously, humans were considered one of the factors, alongside machinery and equipment. However, today, they have become vitally important resources and assets in competitive battles, due to their capacity for creativity, which has become a decisive condition for the success of any activity.

The aforementioned range of questions and issues related to global development, the place and role of education, aims to determine the most practical and general approaches to understanding their essence, the origins of socio-natural and socio-cultural processes, key settings, and priorities.

### **2.3 Improving the quality of the educational process using distance learning technologies**

Distance learning tools are now widely used in the educational industry as the globe gets more linked and technology develops. The COVID-19 epidemic, which has forced many students to use remote learning, has further expedited this tendency. While remote learning technologies have many advantages, like more accessibility and flexibility, there are also difficulties that must be resolved in order to maintain the quality of education. To maximize the potential benefits and overcome the difficulties related to this style of learning, it is critical to identify the best practices and case studies of effective application of remote learning technology.

One of the essential benefits of distance learning advancements is that they give more noteworthy openness and adaptability to students. Understudies are not generally limited by topographical imperatives or time constraints and can get to educational substance from any place and whenever. This permits understudies to deal with their timetables all the more realistic and offset their education with different responsibilities, like work or family.

One more advantage of distance learning innovations is that they give a more noteworthy assortment of learning open doors. Educational organizations can offer a more extensive scope of courses and projects, including those that may not be accessible in customary

homeroom settings. This permits understudies to completely investigate a more extensive scope of points and seek after their inclinations more.

Distance learning innovations likewise give a more customized opportunity for growth. With the utilization of versatile learning advancements and online appraisals, teachers can fit the educational substance to meet the particular necessities of individual students. This permits understudies to advance at their own speed and get more designated criticism on their advancement.

Distance learning advancements have turned into a basic piece of the educational scene, giving more prominent adaptability and openness to students. Nonetheless, guaranteeing the nature of education while utilizing these innovations stays a worry. To amplify the advantages of distance learning advancements, it is fundamental to distinguish and take on prescribed procedures that can improve the educational interaction. Here are the absolute prescribed procedures for working on the nature of the educational interaction utilizing distance learning advancements:

- Foster a reasonable and succinct course structure: A very much planned course structure assists understudies with exploring the growing experience all the more really. The course construction ought to incorporate clear learning goals, definite guidelines, and an obvious evaluation methodology.
- Draw in students with intuitive substance: Intelligent substance can assist with improving understudy commitment and encourage a functioning learning climate. The utilization of media assets like recordings, movements, and interactive recreations can give a seriously captivating growth opportunity.
- Cultivate understudy joint effort: Cooperation among understudies can be empowered through conversation discussions, bunch tasks, and companion audit exercises. This can assist with making a feeling of local area and advance a cooperative learning climate.
- Give opportune and useful feedback: Convenient and valuable feedback can assist understudies with figuring out their advancement and recognize regions for development. The utilization of online appraisal apparatuses and computerized evaluating frameworks can give quick feedback to understudies.
- Guarantee accessibility and inclusivity: Distance learning innovations ought to be intended to oblige the requirements, everything being equal, incorporating those with handicaps. Educational substance ought to be made accessible in open organizations, and mechanical apparatuses ought to be utilized to establish a comprehensive learning climate.

By adopting these prescribed procedures, educational foundations can ensure that advances in distance learning are successfully used to work on the nature of education.

The rise of distance learning advancements has changed the educational scene, empowering foundations to offer adaptable and available learning choices to understudies. The global e-learning market has been on the ascent, with the market size projected to reach \$37 billion by 2026 (Statista, 2021). This development can be credited to different factors, for example, the rising utilization of the web, the expansion of cell phones and tablets, and the requirement for reasonable and adaptable learning arrangements.

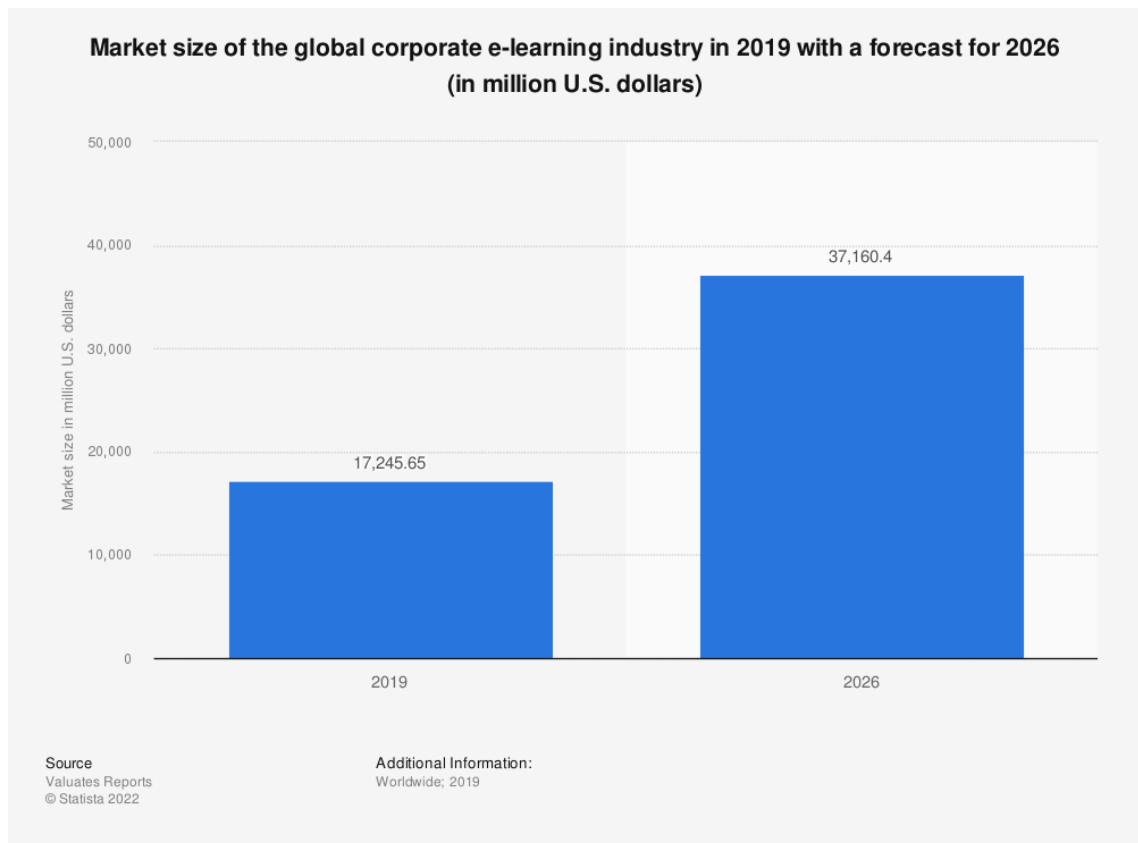


Figure 2.1: Forecast of e-learning market size  
Source: <https://www.statista.com/statistics/1232427/>

Notwithstanding the rising interest for online courses, organizations have been endeavoring to work on the nature of the educational cycle utilizing distance learning advances. A valid example is the far reaching reception of Learning Management Frameworks (LMS) that empower organizations to convey content, oversee evaluations, and give criticism to understudies. These frameworks have been found to improve the productivity of the educational cycle, diminish authoritative errands, and empower educators to zero in on giving quality education to understudies.

Distance learning tools have turned into a vital piece of the education business, offering more noteworthy openness, adaptability, and customized learning open doors to understudies. Notwithstanding, guaranteeing the nature of education while utilizing these innovations stays a worry. To augment the advantages of distance learning progressions, it is urgent to recognize and take on accepted procedures that can work on the educational interaction. These practices incorporate cultivating a reasonable course structure, drawing in understudies with intuitive substance, advancing cooperation, giving convenient and valuable criticism, and guaranteeing openness and inclusivity. With the broad reception of Learning Management Structures, educational organizations can work on the proficiency of the educational cycle and spotlight on giving quality education to understudies. In spite of the difficulties, the global e-learning market is supposed to keep on developing, driven by variables like the rising utilization of the web, the multiplication of cell phones, and the interest for reasonable and adaptable learning arrangements.

## **3. World Wide Web**

### **3.1 Definition and history of the World Wide Web**

The Internet (WWW or just, the web) is a worldwide data framework that permits clients to access and share records, media, and different assets through interconnected hypertext reports utilizing the Web. The web was designed by Sir Tim Berners-Lee, an English PC researcher, in 1989 while working at CERN (European Association for Atomic Exploration) (Gillies and Cailliau, 2000). At first planned as a way for researchers to team up and share research information, the web has since developed into a fundamental instrument for correspondence, business, training, and diversion (Berners-Lee, 2010).

The web depends on three essential parts: Uniform Resource Locators (URLs), Hypertext Markup Language (HTML), and Hypertext Transfer Protocol (HTTP). URLs are utilized to interestingly distinguish assets on the web, while HTML is a markup language used to structure content and make joins between assets. HTTP is the convention that empowers correspondence between web servers and clients, working with the exchange of HTML reports and different assets

### **3.2 How the web works: Internet protocols and technologies**

The web works on a client-server model, where clients (clients) demand assets from web servers by utilizing internet browsers. The client-server correspondence is worked with through different Web conventions and advancements, including DNS, IP, TCP, and HTTP/HTTPS (Kurose and Ross, 2017).

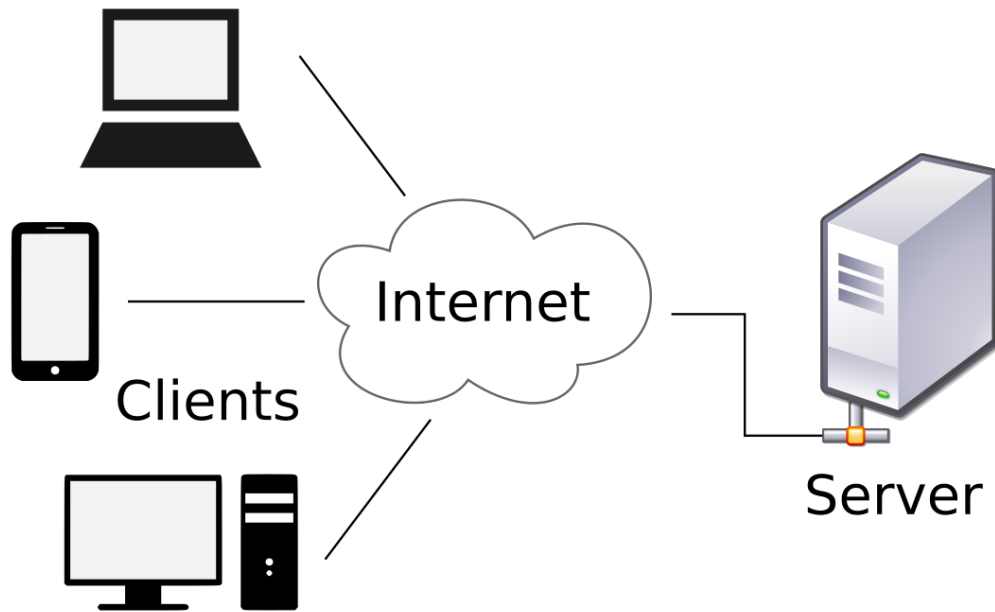


Figure 3.1: A simplified representation of the client-server communication model used by the web.

Source: <https://lse-my472.github.io/week05/MY472-week05-scraping-1.pdf>

1. Space Name Framework (DNS): When a client enters a URL in an internet browser, the DNS deciphers the comprehensible space name (e.g., `www.example.com`) into a Web Convention (IP) address (e.g., `192.0.2.1`) that exceptionally distinguishes the web server facilitating the mentioned asset (Kurose and Ross, 2017).
2. Web Convention (IP): IP is answerable for directing information parcels between gadgets over the Web. It is a connectionless convention, implying that it doesn't lay out a consistent association between the source and beneficiary (Kurose and Ross, 2017).
3. Transmission Control Convention (TCP): TCP is an association situated convention that works related to IP to guarantee the solid conveyance of information bundles. It lays out an association between the client and the server, deals with the progression of information, and reassembles the information parcels at the objective (Kurose and Ross, 2017).
4. HTTP/HTTPS: The Hypertext Move Convention (HTTP) and its protected variation (HTTPS) are application layer conventions that work with the exchange of HTML records and different assets among clients and servers. HTTPS utilizes Transport Layer Security (TLS) to scramble and get the correspondence between the client and the server (Rescorla, 2018a).

The most common way of mentioning and getting a web asset regularly includes the accompanying advances:

1. The client enters a URL in the internet browser.
2. The program sends a DNS question to determine the space name to an IP address.

3. The program lays out a TCP association.
4. The program lays out a TCP association with the web server utilizing the IP address got from the DNS inquiry.
5. The program sends a HTTP or HTTPS solicitation to the server, indicating the ideal asset, for example, a website page or a picture.
6. The web server processes the solicitation and sends back a HTTP or HTTPS reaction containing the mentioned asset, alongside metadata, for example, the status code and content sort.
7. The program gets the reaction, deciphers the HTML, CSS, and JavaScript, and renders the website page for the client. If extra assets, like pictures or recordings, are required, the program sends extra demands to the server.
8. When the correspondence is finished, the program and server close the TCP association.

This cycle shows how different Web conventions and advancements cooperate to work with the proficient and dependable conveyance of web assets.

### **3.3 The evolution of web technologies**

Throughout the long term, the web has seen quick headways in innovation and design, driven by the requirement for further developed performance, security, and client experience. Key improvements include:

1. Web 2.0: during the 2000s, Web 2.0 emerged, portrayed by a shift from static web pages to dynamic, natural web applications that work with client created content and one individual to the next correspondence (O'Reilly, 2007). Headways like AJAX (Unique JavaScript and XML) considered nonconcurrent correspondence between the client and server, engaging predictable updates and instinct without requiring full page reloads (O'Reilly, 2007).
2. Responsive Web Design (RWD): As cell phones acquired notoriety, the requirement for websites that could adjust to different screen sizes and goals became obvious. Ethan Marcotte presented the idea of Responsive Web Design in 2010, which utilizes liquid matrices, adaptable pictures, and CSS media questions to make a solitary, versatile design that can oblige various gadgets and show sizes (Marcotte, 2011).
3. Web performance optimization: As web applications turned out to be more intricate, the requirement for quicker stacking times and further developed performance turned into a basic concern. Strategies like minification, pressure, sluggish stacking, and Content Conveyance Organizations (CDNs) were created to improve the conveyance of web assets and upgrade the client experience (Souders, 2007).
4. HTML5 and CSS3: HTML5 and CSS3, presented in 2014 and 2012 separately, carried new elements and abilities to web advancement. HTML5 presented new semantic components, sight and sound help, and APIs for highlights like geolocation and neighborhood stockpiling, while CSS3 presented progressed styling abilities like angles, changes, and movements (Frain, 2012).

5. **Progressive Web Apps (PWAs):** PWAs are web applications that consolidate the best highlights of the two websites and local applications, giving a smooth and predictable client experience across different gadgets and stages. They offer disconnected abilities, message pop-ups, and can be introduced on the client's gadget, obscuring the line among web and local applications (Russell and Berriman, 2019).

These progressions represent the ceaseless advancement of web innovations, driven by the need to satisfy the always developing needs of clients, designers, and organizations.

## **3.4 Frontend Development**

### **3.4.1 Definition and Purpose**

Frontend development is the method involved with making the UI and client experience of a web application. It includes designing, styling, and adding intuitiveness to web pages utilizing a blend of languages and technologies. The essential objective of frontend development is to furnish clients with an outwardly engaging, utilitarian, and open point of interaction, upgrading their general insight and commitment with the web application (Frain, 2012).

### **3.4.2 Key Frontend Languages and Technologies**

#### **HTML**

HTML (Hypertext Markup Language) is a markup language that characterizes the design and content of web pages. It utilizes an arrangement of labels to mean components like headings, passages, records, and connections, which are delivered by web programs to show the page's substance (Paoli et al., 2017).

#### **CSS**

CSS (Cascading Style Sheets) is a stylesheet language that controls the introduction of web pages. It permits engineers to apply styles (e.g., varieties, textual styles, and format) to HTML components, isolating the design from the substance and guaranteeing a predictable look and feel across web pages (Frain, 2012).

#### **JavaScript**

JavaScript is a programming language that empowers designers to add intuitiveness and dynamic substance to web pages. It considers highlights like activities, structure approval, and information bringing from servers, making web applications seriously captivating and responsive to client activities (Flanagan, 2011).

### **3.4.3 Frontend Frameworks and Libraries**

#### **React**

React is a famous JavaScript library created by Facebook for building UIs. It presents a part based engineering, making it more straightforward to make reusable and measured UI components. React likewise carries out a virtual DOM to improve delivering performance, bringing about quicker and more responsive applications (F. Inc., 2021).



## **Angular**

Angular is a broadly utilized, open-source frontend system created by Google. It utilizes an explanatory way to deal with building UIs, with an emphasis on two-way information restricting, reliance infusion, and measured quality. Angular is appropriate for building enormous scope, complex applications, and has a dynamic biological system of devices and libraries (G. Inc., 2021).

## **Vue.js**

Vue.js is a lightweight, open-source JavaScript structure for building UIs. It offers an adaptable, steady way to deal with frontend development, permitting engineers to take on its highlights depending on the situation. Vue.js underlines straightforwardness and convenience while giving strong highlights like reactive information restricting, parts, and a virtual DOM.

### **3.4.4 Responsive Design and Cross-Platform Compatibility**

Responsive design is a way to deal with web design that guarantees web pages render well on various gadgets and screen sizes. It utilizes liquid lattices, adaptable pictures, and CSS media inquiries to adjust the format and design of a web page in view of the client's gadget, guaranteeing a reliable and ideal client experience across different screen sizes and goals (Marcotte, 2011). Cross-platform compatibility is fundamental for frontend development as clients progressively access web applications from different gadgets, including work areas, PCs, tablets, and cell phones.

## **3.5 Backend Development**

### **3.5.1 Definition and Purpose of Backend Development**

Backend development alludes to the server-side of programming development, zeroing in on information capacity, handling, and the executives. The basic role of backend development is to work with correspondence between the frontend (UI) and the backend (information capacity and handling) parts of a product application. Backend designers make and keep up with the rationale, server arrangements, and foundation that empower consistent information stream and guarantee the framework's unwavering quality, performance, and security.

### **3.5.2 Key Backend Languages and Technologies**

#### **Python**

Python is a flexible, undeniable level programming language known for its clarity and straightforwardness. Broadly took on in backend development, Python offers broad libraries and frameworks that help web development, information handling, and control. Its fame in the backend development local area comes from its convenience, broad help, and versatility (P. S. Foundation, 2023).

## **Ruby**

Ruby is an item situated, unique programming language that focuses on effortless and productivity. It is famous for backend web development because of its succinct linguistic structure, broad libraries, and the strong Ruby on Rails system. Ruby's attention on engineer insight and quick prototyping pursues it an alluring decision for new businesses and light-footed development groups (Language, 2023).

## **PHP**

PHP (Hypertext Preprocessor) is an open-source, server-side prearranging language designed for web development. It is generally utilized in backend development because of its quick execution, simplicity of joining with HTML, and broad help for different data sets. PHP offers a scope of frameworks, libraries, and content administration frameworks that improve and smooth out the development cycle (Group, 2023).

## **Node.js**

Node.js is a JavaScript runtime based on Chrome's V8 motor, empowering engineers to compose server-side code utilizing JavaScript. It has acquired prominence in backend development because of its non-impeding, occasion driven design, which considers productive handling of simultaneous associations. The broad biological system of libraries and frameworks accessible for Node.js, alongside its compatibility with frontend JavaScript code, settles on it an alluring decision for full-stack development (N. Foundation, 2023).

## **Golang**

Golang, or Go, is an open-source programming language created by Google that spotlights on effortless, proficiency, and solid help for simultaneous programming. Go has acquired notoriety in backend development because of its noteworthy performance, static composing, and simplicity of arrangement. Its advanced design major areas of strength for and library make it appropriate for growing elite performance web servers, APIs, and microservices (Authors, 2023).

### **3.5.3 Backend Frameworks and Libraries**

#### **Django**

Django is an undeniable level Python web structure that energizes fast development and spotless, logical design. It incorporates worked in help for normal web development errands, for example, confirmation, structure handling, and data set administration, permitting engineers to zero in on composing application rationale as opposed to standard code (Project, 2023).

#### **Ruby on Rails**

Ruby on Rails, or just Rails, is a web application structure based on the Ruby programming language. It follows the Model-View-Controller (MVC) engineering design and underscores show over arrangement, which decreases how much redundant code and improves on the development interaction. Rails is known for its convenience and quick prototyping abilities (Rails, 2023).

## **Laravel**

Laravel is a PHP web application structure that gives an exquisite grammar and a scope of instruments for normal backend development errands. It follows the MVC example and offers elements, for example, directing, confirmation, and storing. Laravel is well known for its vigorous environment and dynamic local area, which add to its broad bundle store and backing (Laravel, 2023).

## **Express**

Express is a negligible and adaptable Node.js web application system that gives a powerful arrangement of highlights for building web applications and APIs. It is a famous decision for backend development with Node.js because of its effortless, performance, and broad middleware support. Express works with the quick development of server-side applications by giving a meager layer of basic elements without clouding the hidden Node.js capacities (Express, 2023).

### **3.5.4 Databases and Data Storage**

#### **SQL Databases**

SQL (Organized Question Language) databases are social databases that store data in tables and use SQL for questioning and controlling the data. They are broadly utilized in backend development because of their power, consistency, and simplicity of querying. Well known SQL databases incorporate MySQL, PostgreSQL, and Microsoft SQL Server (MySQL, 2023).

#### **NoSQL Databases**

NoSQL databases are non-relational databases that store data in different configurations, like key-value, document, column-family, and graph. They offer greater adaptability and scalability contrasted with SQL databases, making them appropriate for handling enormous volumes of unstructured or semi-organized data. Famous NoSQL databases incorporate MongoDB, Cassandra, and Redis (MongoDB, 2023).

### **3.5.5 Server Architecture and Scalability**

Server architecture and scalability are basic parts of backend development, as they decide the application's capacity to handle expanding responsibilities and oblige development. Backend engineers should consider factors, for example, load adjusting, level and vertical scaling, reserving, and microservices architecture to guarantee ideal performance, unwavering quality, and asset use. Taking on proper server architecture and scalability methodologies permits applications to serve a developing client base productively and keep up with elevated degrees of performance.

## **3.6 APIs(Application Programming Interfaces)**

Application Programming Interfaces (APIs) assume a vital part in frontend development, empowering correspondence between different programming parts, administrations, and applications.

### **3.6.1 Definition and purpose of APIs**

APIs are a bunch of rules, protocols, and instruments that work with collaboration between programming parts(Roy Thomas Fielding, 2000). They give a standardized and effective way for programming applications to convey, access data, and offer usefulness. APIs improve on the development interaction by abstracting the fundamental execution and uncovering just the important parts, permitting engineers to zero in on building their applications without agonizing over the complexities of different frameworks.

### **3.6.2 Sorts of APIs: RESTful, GraphQL, SOAP, and so on**

There are different sorts of APIs, each with its design theory and use cases:

**RESTful APIs:** Representational State Transfer (REST) is a building style for designing organized applications(Roy Thomas Fielding, 2000). RESTful APIs use HTTP methods (GET, POST, PUT, DELETE) to perform activities and normally convey utilizing JSON or XML. RESTful APIs are stateless, cacheable, and stick to a client-server architecture(Pautasso et al., 2008).

**GraphQL:** GraphQL is a question language for APIs created by Facebook(G. Foundation, 2021). It gives an adaptable and effective way for clients to demand the specific data they need, decreasing how much finished or under-getting of data. GraphQL APIs utilize a solitary endpoint, and clients determine the data structure they expect in their questions.

**SOAP:** Simple Object Access Protocol (SOAP) is a protocol for trading organized data in the execution of web administrations(Box et al., 2000). SOAP involves XML as its message design and can be moved over different protocols, like HTTP and SMTP. SOAP is known for serious areas of strength for its, formal agreements (WSDL), and support for complex activities.

### **3.6.3 Authentication and authorization mechanisms**

Authentication and authorization are fundamental parts of API security. Authentication confirms the personality of clients or frameworks accessing the API, while authorization decides the activities they are allowed to perform(Hardt, 2012). Normal authentication mechanisms incorporate API keys, OAuth 2.0, JSON Web Tokens (JWT)(Jones et al., 2015), and OpenID Associate. Authorization can be overseen through job based access control (RBAC), trait based access control (ABAC), or other custom mechanisms.

### **3.6.4 API design best practices**

API design best practices center around making predictable, solid, and effective APIs. A few key standards include(Roy T Fielding and Taylor, 2002):

Utilize clear and illustrative naming shows. Adhere to laid out guidelines, like REST or GraphQL. Utilize forming to oversee API updates and changes. Use suitable status codes and mistake messages. Execute pagination, separating, and arranging for proficient data recovery. Guarantee legitimate safety efforts, including authentication, authorization, and rate restricting.

### **3.6.5 API documentation and forming**

API documentation is pivotal for engineers to actually understand and utilize APIs. Exhaustive documentation ought to remember data for endpoints, demand/reaction designs, authentication mechanisms, mistake handling, and models. Apparatuses like Swagger(Swagger, 2021) and API Blueprint(Blueprint, 2021) can help create and keep up with API documentation. Forming takes into consideration updates and changes to APIs while keeping up with in reverse compatibility for existing clients. Normal forming approaches incorporate URL-based forming, boundary based forming, or header-based forming.

## **3.7 Combination of Frontend, Backend, and APIs**

### **3.7.1 Communication between frontend and backend using APIs**

The combination of frontend, backend, and APIs is a vital part of present day web application development. APIs act as an extension between the frontend and backend parts, empowering consistent communication and data trade(Pautasso et al., 2008). Frontend applications normally send HTTP solicitations to APIs, which thus process the solicitations, associate with backend frameworks and databases, and return the fitting reactions to the frontend. This detachment of worries permits engineers to fabricate measured, versatile, and viable applications, guaranteeing that every part can develop freely without influencing the others(Pautasso et al., 2008).

### **3.7.2 Common patterns for web application architecture**

Web application architecture is a system for designing and organizing applications to meet explicit necessities and accomplish wanted performance levels. A few common patterns for web application architecture incorporate the Model-View-Controller (MVC), Model-View-ViewModel (MVVM), and microservices architecture(Richardson and Smith, 2018). The MVC design advances the partition of worries by isolating an application into three interconnected parts: the model (data), the view (UI), and the controller (application rationale). The MVVM design broadens the MVC approach by presenting a ViewModel, which fills in as a go between the view and the model, improving on data restricting and state the board. Microservices architecture includes separating an application into more modest, free administrations that speak with one another through APIs, empowering better scalability, adaptability, and practicality(Richardson and Smith, 2018).

### **3.7.3 Security considerations and best practices**

Security is a foremost worry in web application development, as weaknesses can prompt data breaks, unapproved access, and different dangers. A few best practices for guaranteeing security in frontend-backend-API combination include:

Carrying areas of strength for out and authorization mechanisms, for example, OAuth 2.0(Hardt, 2012), JSON Web Tokens (JWT)(Jones et al., 2015), and job based access control (RBAC). Utilizing HTTPS to scramble data sent between the frontend and the backend by means of APIs, safeguarding delicate information and keeping up with data trustworthiness(Rescorla, 2018b). Disinfecting and approving client inputs to forestall

security dangers, for example, SQL injection, cross-site scripting (XSS), and other code injection assaults(*OWASP Top Ten Project 2021*). Routinely refreshing programming conditions, libraries, and frameworks to address security weaknesses and keep up with state-of-the-art assurance(*OWASP Dependency-Check 2021*).

# **Methodological part**

## **4. Analysis of educational programs in universities in the United States and the Czech Republic**

### **4.1 The Economics Program at Kansas State University**

Kansas State University, known as K-State, is a public research university that serves around 25,000 students yearly. The school's fundamental grounds is situated in Manhattan, Kansas, and branch grounds can be tracked down in Salina as well as in Olathe. The oldest state funded college in the state, it presently grants bachelor's, master's, doctoral and specialist degrees. It is locally authorize by the North Central Association of Colleges and Schools. The university characterizes its central goal to some extent as "creating human potential, expanding knowledge, enriching cultural expression and stretching out its skill to people, business, instruction and government."

The Department of Economics offers undergraduate programs prompting a bachelor's or alternately bachelor's certificate. What's more, numerous students supplement their significant field of study with a minor in economics. Students with outstanding scholarly execution can join a sped up master's program prompting a bachelor's certificate in economics toward the finish of four years of study and a master of arts in economics toward the finish of five years.





About

Academics

Student Success

**B.A./B.S. in Economics**

**Accelerated Masters Program**

**Minor in Economics**

**Ph.D. Program**

**M.A. Program**

Figure 4.1: Academics «Economy» Kansas State University

Source: <https://www.k-state.edu/economics/>

While pursuing a bachelor's or bachelor's degree, students pick either an overall degree choice and four different specific tracks. The overall degree is intended to give flexibility. This works well for the people who need to pick their own field of study or maybe seek after a second major in an alternate field. Numerous students decide to have practical experience in a smaller area of economics and pick one of the tracks inside the major. The tracks are intended to offer students the chance to foster those skills that are generally pertinent to a specific area of economics.

Other opportunities:

**Scholarships** The department presently grants around thirty scholarships to students, and that number is developing.

**Mentoring Program** The department's mentoring program pairs students with alumni who have been successful in an area of interest to the student. The program is an incredible method for interfacing with the future and investigate life after graduation with a mentor devoted to student advancement.

**Economics Club** The Economics Club is designed to unite students who share an interest in economics and to create a stimulating environment in which that interest can thrive. The meetings typically feature speakers from academia or industry who apply economics in their day-to-day routines. The club organizes a series of high-profile

events in which prominent economists discuss the major issues in economics. The club also hosts frequent social gatherings and arranges field trips each year. Recent outings include Chicago, Topeka, and Boston. Next up is Washington, D.C.

**Specialization in Economics.** Economics is connected with numerous other disciplines in significant ways. Along these lines, students frequently discover that adding an economics major is an effective method for finishing their studies. Students can seek after specific studies in financial theory, cash and banking, public money, work economics, worldwide exchange, monetary turn of events, transportation, econometrics, local economics, modern association, and monetary frameworks.

The department offers both an overall schooling choice and four different particular tracks. The tracks are intended to offer students the chance to develop the skills that are generally most relevant to a specific area of economics. While the arrangement of electives in economics and past is more restricted for the track approach, the number of credit hours expected to finish the program continues as before.

#### **4.1.1 Economic Analyst**

Policy analysis is an excellent way to learn and apply economics. Understanding the relationship between policy and economic outcomes requires a balance of technical tools and basic knowledge of economic institutions. The economic policy major provides this balance with instruction on a range of policy issues and enough technical training to delve deeply into data related to specific issues. Students can study public policy related to macroeconomics, labor markets, business, international trade, and public finance.

This track would be ideal for students seeking a regulatory degree, a position in a less technical role, or a master's degree in public policy. It is also a good choice for those seeking a well-rounded education in economics. Developed critical thinking skills will be widely applicable as graduates pursue careers in the private or public sectors.

The economic policy track is more restrictive than the general degree option. Nonetheless, it offers considerable flexibility while providing sufficient exposure to policy issues. The track requires a course in formal logic or moral philosophy and another in U.S. politics or political thought. The economics electives require students to take at least two courses: labor economics, econometrics, public finance, and industrial organization and public policy. The remaining three economics electives must be chosen from a set of 10 courses with a substantial policy analysis component.

#### **4.1.2 Business Economics**

Most economics majors enter the business world after graduation. The economic mindset and tools of the trade can be useful in any business environment. A basic understanding of more purely business topics is a useful addition to a graduate's economic knowledge when beginning a business career.

The Business Economics major focuses on preparing students with the economic knowledge most important for success in the business world. It combines a thorough approach to economics for real-world applications with general business experience. For double majors, this course blends well with a business degree and focuses on providing a rich mix of business and economics skills. It is also excellent preparation for those considering an

MBA.

This course requires introductory courses in accounting and finance and allows students to choose between additional accounting instruction or an introductory course in management or marketing. Students are encouraged to take an introductory course in each of these areas. As part of the economics electives, students choose from a set of courses that focus on issues relevant to the business world. Some examples include Industrial Organization, Strategic Behavior and Game Theory, Labor Economics, and several courses on international trade and finance.

#### **4.1.3 Financial Economics**

For some students, a premium in the stock market and other financial markets creates an underlying premium in the investigation of economics. Understanding the economic forces that lead to fluctuations in stock costs, loan fees, and trade rates gives a significant benefit to anybody working in the financial administrations area. Therefore, it isn't is business as usual that a huge piece of K-State economics majors work in the financial administrations industry.

The Financial Economics course is intended for the individuals who need to enter the financial business with an economics degree. Students who pick this track will be ready for advanced work in the business. The track gives inside and out knowledge of financial markets and the components that drive them. It likewise furnishes students with logical devices for fieldwork.

The necessities are like those of the Business Economics course. Students take basic courses in accounting and finance. They additionally browse value protections and markets courses in the finance department and economics courses most firmly connected with finance. These incorporate cash and banking, econometrics, international finance, and open economy macroeconomics, as well as monetary, credit, and fiscal policy. Electives in economics are enhanced by a choice of the accompanying courses: Key Way of behaving and Game Theory, Modern Association and Public Policy, and International Economics. Students are additionally urged to take our time series examination and estimating course.

#### **4.1.4 Analysis of the organization of the online learning process**

Kansas State University (K-State) has embraced online learning to give adaptability and openness to many students. By incorporating technology and informative design, K-State has made an exhaustive and drawing in online learning environment. The accompanying analysis frames the association of online learning at K-State.

Global Campus: The K-State Global Campus fills in as the center point for distance schooling and online learning, giving a centralized stage where students can get to online courses and programs. The Global Campus offers undergraduate, graduate, and expert development programs, as well as endorsement programs, in different fields of study.

Search

### Advanced Search

**Term**      Limit results to courses during:

**College**      Limit results to courses in:

**Credit Level**      Limit results to courses for:

**Credit Hours**      Limit results to courses of:

*(Select multiple options by holding CTRL)*

**Dates**      Limit results to courses between:

**Class Time**      Limit results to courses between:

h:mm pm                      h:mm pm

Limit results to courses eligible for:  UGE Credit     K-State 8 Credit

Limit results to courses of length:  8 weeks     16 weeks

Limit results to courses that are:  Completely Accessible from Home

Search

Figure 4.2: Course Search in Global Campus

Source: <https://global.k-state.edu/>

**Course Design and Development:** Online courses at K-State are designed and created with the assistance of informative designers who work intimately with faculty individuals. This collaboration guarantees that courses keep up with high scholarly standards while using best practices in online teaching method. The design cycle incorporates making clear learning targets, consolidating drawing in happy, and designing evaluations that line up with course goals.

**Student Support Services:** K-State gives a scope of support services for online students to guarantee their prosperity. These services incorporate scholarly prompting, coaching, technical support, library resources, and incapacity facilities. Online students likewise approach K-State’s Profession Community, which offers vocation direction, pursuit of employment help, and networking open doors.

**Learning Management System (LMS):** K-State utilizes the Material LMS to convey its online courses. Material gives an easy to understand connection point to students and instructors to cooperate, share resources, and oversee coursework. It supports different interactive media formats, discussion forums, quizzes, and assignment submissions.

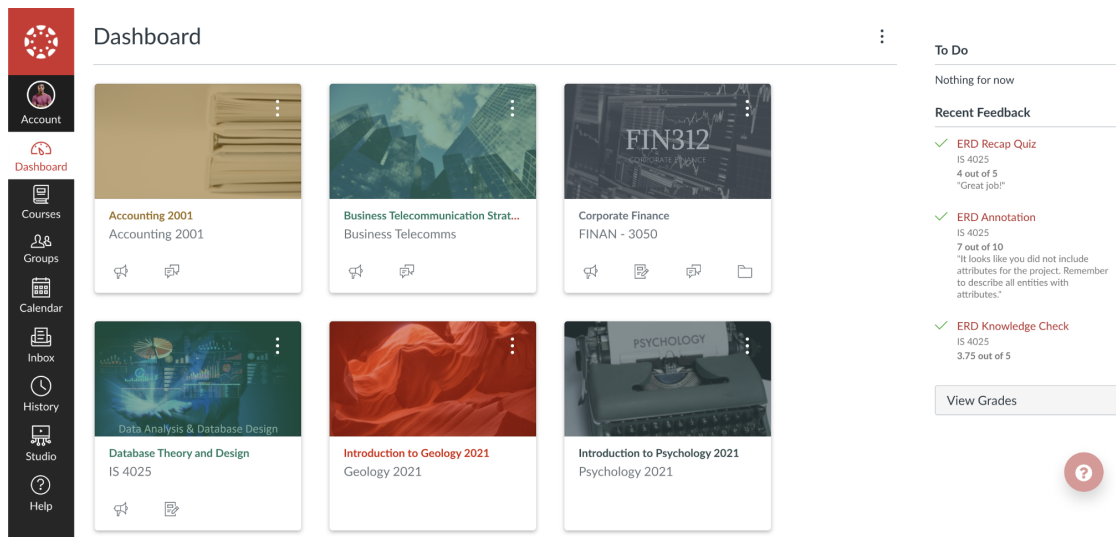


Figure 4.3: Example of dashboard in Canvas

Source: <https://www.instructure.com/canvas>

Faculty Training and Support: K-State perceives the significance of getting ready faculty for the exceptional difficulties of online guidance. The university gives training, resources, and support for faculty to assist them with changing from customary study hall educating to online guidance. This incorporates workshops, online instructional exercises, and one-on-one discussions with educational designers and technologists.

Community Building: K-State puts serious areas of strength for an on making a feeling of community among online students. The university empowers student cooperation through discussion forums, bunch projects, and virtual entertainment. Also, instructors are encouraged to keep up with standard correspondence with their students and give convenient feedback on assignments.

## 4.2 The CTU MIAS Economics and Management educational program

The Czech Technical University Masaryk Institute of Advanced Studies(CTU MIAS) was founded in 1992 as an educational institution with university institute status, offering accredited bachelor's, master's, and doctoral programs. It also provides educational programs specifically designed for graduates of Czech and foreign universities and delivered in the form of job training. The main areas of education are economics and management, engineering, and language training. CTU MIAS cooperates with Czech and foreign universities, industrial enterprises, government institutions, and leading Czech and foreign experts. The institute is a founding member of the Czech Association of MBA Schools (CAMBAS), a member of the Czech Management Association (SHORT), the Czech HR Club, and the International Society for Engineering Education (IGIP).

The three-year undergraduate program in economics and business administration equips students with in-depth knowledge of economics, business, and management in an international environment, as well as technical and technological expertise. Graduates can apply for entry-level positions in various technical and operational management, finance,


marketing, sales, human resources, and public administration fields. Successful graduates will earn a Bachelor of Science (BSc) degree. They may also continue their studies in the CTU MIAS Master's Program in Innovation and Project Management or other training programs in the Czech Republic and abroad.

The purpose of the specialization is to help students obtain an education focused on entrepreneurship and management in an industrial enterprise environment. Graduates of the specialization will be able to find jobs in middle management positions in Czech and foreign companies, especially those operating in the EEC. Mastery of basic technical and management knowledge will enable graduates to find employment in positions requiring comprehensive knowledge of both areas, for example, managing the technical department of an industrial enterprise, overseeing the production or sales department, or directing the marketing department. Considerable attention is paid to learning English, which enables graduates to work in foreign companies or foreign branches of Czech and foreign companies.

The curriculum takes benefit of the favorable environment of the oldest and best Czech technical university, which is an individual from the Eurotech Engineering family. This group plans to advance collaboration between six in number mechanical colleges and 45 related accomplices, adding to the European soul in creative engineering schooling all through the country.

To successfully enroll, candidates should breeze through the placement test, which comprises of two tests: mathematics and English (B2 level as indicated by CEFR). Required subjects include: mathematics, business economics, software engineering, accounting standards, coordinated operations, and HR management 4.4.

The bachelor's degree program incorporates a three-month entry level position at incredibly famous organizations. The entry level position takes place in the fifth semester.



**Economics and Management**  
Undergraduate Bachelor's Degree Curriculum

1 year		2 year		3 year	
1. semester	2. semester	3. semester	4. semester	5. semester	6. semester
Mathematics 1	Mathematics 2	Statistics 1	Statistics 2	Management Science	Quality Management
Business Economics	Principles of Accounting	Human Resources Management	Principles of Corporate Finance	International Financial and Tax Environment	BSc Thesis
Informatics	Logistics	Information Systems	Research Thesis Seminar		
Principles of Management	Principles of Project Management	Managerial Psychology	Macroeconomics		
Physical Education 1	Principles of Marketing	Microeconomics			
	Physical Education 2	Principles of Law			
Technical Course 1		Technical Course 2		Technical Course 3	
Czech culture and Civilization 1	Czech culture and Civilization 2	Social Competences Course	Social Competences Course	Social Competences Course	Social Competences Course
Czech for Foreigners 1	Czech for Foreigners 2	Social Competences Course	Professional Course	Professional Course	Professional Course

● Compulsory Courses  
● Technical Courses  
● Social Competences Courses, Professional Courses

Figure 4.4: Curriculum for students studying in the academic year 2022/2023 Economics and Management

Source: <https://www.muvs.cvut.cz/en/>

**Recommended study plan:** 1st semester - compulsory courses (21 ECTS), social competences courses (6 ECTS), technical courses (3 ECTS); 2nd semester - compulsory courses (24 ECTS), social competences courses (6 ECTS); 3rd semester - compulsory courses (21 ECTS), social competences courses (6 ECTS), technical courses (3 ECTS); 4th semester - compulsory courses (18 ECTS), social competences courses (6 ECTS), professional courses (6 ECTS); 5th semester - compulsory courses (9 ECTS), social competences courses (6 ECTS), technical courses (3 ECTS), professional courses (12 ECTS); 6th semester - compulsory courses (9 ECTS), social competences courses (6 ECTS), professional courses (15 ECTS).

CTU uses the ECTS credit system, as most universities in Europe (Table 2). This system facilitates the transfer of credits between universities, as well as the recognition of educational programs completed at other institutions and in other countries. For the 3-year bachelor's program students must complete 180 credits, and for the two-year master's program students must complete 120 credits. Students must also take a state exam before graduation. For the doctoral program, students must take a small number of accredited courses, but the primary requirement is a doctoral dissertation. Students must complete at least 15 or 20 credits to pass the semester. To advance to the next year of the curriculum, 40 credits must be completed.

#### 4.2.1 Analysis of the organization of the online learning process

The Czech Technical University in Prague, Masaryk Institute of Advanced Studies (CTU MIAS) utilizes the Moodle Learning Management System (LMS) for its online learning process. This analysis focuses on the strengths and weaknesses of Moodle as the LMS for

CTU MIAS and CTU as a whole.

Moodle's widespread adoption and success as a Learning Management System (LMS) can be attributed to several factors. Firstly, its open-source nature allowed educational institutions and organizations to access and implement the platform at minimal cost. Secondly, Moodle offered a vast range of features that catered to the diverse needs of its users, such as content management, assessment tools, and communication channels. Finally, its robust community of developers and users provided valuable resources and support, facilitating the continuous improvement of the platform. As a result, Moodle became a popular choice among organizations seeking a cost-effective and feature-rich LMS.

However, as the landscape of online learning continues to evolve, the demands and expectations of users have significantly changed. The rapid development of technology has introduced new methods of delivering educational content, such as immersive learning experiences and adaptive learning pathways. Furthermore, the integration of advanced analytics and artificial intelligence has created opportunities for personalized learning and real-time feedback, enabling educators to better cater to the individual needs of their learners. In this rapidly changing environment, it has become increasingly challenging for Moodle to keep pace with the innovations and provide users with the cutting-edge tools and experiences they now expect from an LMS.

In light of these developments, it has become imperative for organizations to consider alternatives to Moodle that are better equipped to meet the evolving demands of the online learning landscape. While Moodle has been a reliable and valuable platform for many years, it may no longer provide the best solution for organizations seeking to deliver a modern, engaging, and personalized learning experience. By exploring and adopting more advanced LMS platforms that offer improved functionality, seamless integration, and enhanced user experiences, organizations can ensure that they remain at the forefront of online learning and continue to provide the highest quality education for their learners.



Table 4.1: Strengths and Weaknesses of Moodle

<b>Moodle</b>	
<b>Strengths</b>	
1.	Open-source: Moodle is an open-source platform, allowing CTU MIAS to customize and modify the LMS according to its specific needs and requirements without incurring licensing fees.
2.	Extensive plugin library: Moodle has a vast library of plugins, allowing the university to add various functionalities and features to enhance the online learning experience.
3.	Active community support: Moodle has a large and active community, which provides continuous support and contributes to the platform's development and improvement.
4.	Scalability: Moodle can handle a large number of users and courses, allowing CTU MIAS to manage its growing student population effectively.
5.	User-friendly interface: Moodle offers an intuitive user interface, enabling both students and instructors to navigate and use the platform with ease.
<b>Weaknesses</b>	
1.	Performance issues: Moodle can sometimes experience performance issues, such as slow page loading times or server crashes, especially when dealing with a large number of concurrent users.
2.	Complexity: Moodle's extensive features and customization options can make it difficult for users to find and use specific functionalities, resulting in a steep learning curve for new users.
3.	Limited integration with external tools: Although Moodle has many plugins, it may not integrate seamlessly with certain external tools and services, requiring additional effort to set up and maintain these integrations.
4.	Aesthetic limitations: Moodle's default user interface may appear outdated or unappealing, which can impact user engagement and satisfaction.
5.	Maintenance and support: As an open-source platform, CTU MIAS is responsible for maintaining and updating its Moodle instance, which can require significant time, effort, and resources.

Source: Own elaboration

Considering the challenges outlined in Table 4.1 related to distance learning at CTU, as well as the limitations of the Moodle platform, we have established a goal: to create a web application for organizing online education that enhances the quality of educational services provided by the university.

In the following practical section, we will concentrate on developing an application that addresses all the weaknesses of LMS Moodle as identified in Table 4.1. Additionally, we will conduct an analysis of the cost and duration associated with developing CTU's own LMS, providing insight into the feasibility and necessity of such a project.

## **4.3 Web application specification**

### **4.3.1 Introduction**

This document outlines the specifications for a custom Learning Management System (LMS) designed for CTU. The primary goal of this LMS is to address the weaknesses and provide an efficient, user-friendly platform for students and teachers. The LMS is built using modern programming languages and frameworks, ensuring an up-to-date, reliable, and efficient system.

### **4.3.2 User Roles**

The LMS supports two main user roles:

1. Teacher
2. Student

#### **Teacher**

Teachers have the ability to:

- Create assignments
- Upload and manage study materials
- Establish and assign grades for assignments

#### **Student**

Students have the ability to:

- Access and utilize study materials
- Submit assignments
- View their grades
- Monitor the schedule and deadlines

## **4.4 Features and Functionalities**

### **4.4.1 User-friendly Interface**

The LMS offers a modern, intuitive user interface that enables both students and teachers to navigate and use the platform with ease.

### **4.4.2 Modern Programming Languages and Frameworks**

The LMS is built using the latest programming languages and frameworks, ensuring a reliable, efficient, and scalable system.

### **4.4.3 Role-based Access Control**

The LMS implements role-based access control, ensuring that users have access to the appropriate features and functionalities based on their role (teacher or student).

### **4.4.4 Assignment Management**

Teachers can create and manage assignments, while students can submit assignments, and view their grades.

### **4.4.5 Study Material Management**

Teachers can upload and manage study materials, making them easily accessible to students for their courses.

### **4.4.6 Schedule and Deadline Monitoring**

The LMS includes a scheduling and deadline monitoring system, allowing students to keep track of their assignments and other course-related tasks.

# **Practical part**

# **5. Development of a web application, which contributes to improving the quality of educational services in the university**

## **5.1 Development of the Web Application**

### **5.1.1 Requirements and objectives**

Distance learning system is designed to teach students CTU on forms of full-time, part-time education. It is intended to use the system to work for both part-time and full-time study. This system should improve the quality of services provided by the university in training, the creation of any courses and educational programs in the various fields of science.

The result of the development should lead to a software product that allows the creation of a development environment based on the university's curriculum. Collaboration with the system should be accomplished via the Internet

The distance learning system must meet the following requirements:

- **Accessibility:** The ability to provide access to learning components from a remote access point;
- **Adaptability:** The ability to tailor the curriculum to the individual needs of educational programs;
- **Efficiency:** The ability to increase efficiency and productivity by reducing the time and cost of delivering instructional materials;
- **Durability:** The ability to keep up with new technology without additional and costly rework;
- **Interoperability:** The ability to use learning materials regardless of the platform on which they are created;
- **Reusability:** The ability to use the system in different contexts.

*Requirements for system users.* To restrict users in certain functionalities it is necessary to implement authorization by role. The student should not be able to do what the teacher can do. It is recommended to create three types of users: administrator, teacher, student.

Administrators must have access to all courses and their materials, as well as the ability to add, delete, edit any user in the system.

Teachers should be able to create courses, add learning materials, and test students. It is also important to be able to grade students' work. Students should have access to learning

materials, tests.

A more clear view of user capabilities is shown in the table 5.1.

Table 5.1: User Roles and Functions

User type	User authorization	User functions
Teacher	Yes	<ol style="list-style-type: none"><li>1. Course creation and management</li><li>2. Creating lectures and teaching materials</li><li>3. Development of test assignments</li><li>4. Monitoring of academic progress</li><li>5. Counseling of students</li></ol>
Student	Yes	<ol style="list-style-type: none"><li>1. Study of course materials</li><li>2. Passing control assignments</li><li>3. Consultation with instructors</li><li>4. Control of own results</li></ol>

Source: Own elaboration

*Requirements for the data storage.* The storage must support all the file types you need to learn, such as audio, video, and pictures. The memory capacity of such a system should be able to download at least 100MB for a single file. The system should have good security protection in place to ensure the confidentiality and integrity of stored files. This includes access control, encryption, and regular backups. In the implementation of this application, all downloads will be stored locally.

*Requirements for modernization capability.* The e-learning system ought to have the ability to update and supplant modules. The system model ought to be versatile to changing circumstances during activity and take into consideration staged modernization of individual parts. To accomplish these objectives, object-oriented programming style should be utilized during programming, and necessities for the programming system should be followed.

### 5.1.2 Selection of the Web Application Framework

The selection of tools and frameworks is an important aspect of the development process, as it can address potential problems in the future, make integration of new technologies easier, and enable developers to use communities in order to resolve issues. The decision of backend programming language was somewhat clear, as Golang is an impeccably fit for our requirements. A Learning Management System (LMS) must be capable of delivering fast performance, even under heavy user load. Golang, with its emphasis on microservices and concurrency capabilities, adjusts well to these requirements.

The subsequent step involved selecting a suitable database. PostgreSQL is an ideal choice for your LMS project due to its reliability, stability, and scalability, ensuring consistent performance as your system grows. As an open-source, enterprise-class database, it offers advanced features and extensibility, allowing customization to meet your project's unique needs. Its cross-platform compatibility makes deployment and management on different operating systems straightforward. Furthermore, PostgreSQL has a strong community, providing valuable support and resources for your LMS project.

The decision regarding the authorization and authentication system was fairly straightforward. I aimed to utilize a tool that aligned with the project's requirements while also being popular and supported by a large community. Consequently, I opted for Keycloak.

Utilizing GraphQL in the development of an LMS project offers several benefits. Firstly, it enables more efficient and precise data fetching by allowing clients to request only the data they need, reducing the amount of unnecessary information transferred. Secondly, GraphQL is highly flexible and easily adaptable to any changes in the application, ensuring the LMS remains scalable as it grows. Thirdly, it supports real-time updates through subscriptions, which can be vital for interactive learning experiences. Additionally, GraphQL's strong typing system enhances developer productivity by catching errors early and providing helpful error messages. Finally, the large and active community surrounding GraphQL offers extensive resources and support, making it an appealing choice for an LMS project.

To decide on a helpful and adjusted frontend structure for the LMS, it was important to assess a few famous choices and recognize the one that best met the particular requirements of the framework. A bunch of rules was laid out to look at driving frontend structures, including Vue.js, React.js, and Angular.js, which ultimately guided the selection process.

### **Criteria for selection**

Below are the criteria used to select the most appropriate framework. Important factors for selecting tools include:

1. **Ease of use and learning:** The framework should be easy to understand and use. This will speed up development and reduce the time to learn the framework.
2. **Scalability and performance:** The framework must be able to handle a large number of users and requests while remaining stable and highly productive. It should also be possible to optimize or improve performance.
3. **Community and ecosystem:** The popularity of the framework is very important because the developer will have the ability to refer to materials, books, documentation, and the community when problems arise during the development process.
4. **Flexibility and customization:** The framework is a tool that helps the developer achieve certain results, hence the framework should be easily customizable and flexible.
5. **Compatibility with existing technologies:** The ability to use current technologies is one of the important indicators of framework usage. Depending on the specific task, you can determine the set of technologies used, but usually there is always a need to update and upgrade the functionality or plugins used.
6. **Support and updates:** The chosen framework must always be up-to-date, and therefore constantly supported. Developers must constantly release updates to remain competitive in the market, thus covering more technologies in use and the demand of developers using those technologies.
7. **Maturity and stability:** A mature and stable system will have fewer errors and more reliable features, resulting in a more reliable for any project.
8. **License and cost:** The framework must have a suitable license and cost structure

that fits the budget and requirements of your project. Open-source frameworks are free and offer more flexibility in terms of customization.

### Comparison and evaluation

Here's a comparison table of the frontend frameworks Vue.js, React.js, and Angular.js based on the criteria mentioned at 5.1.2:

Table 5.2: Comparison of Frontend Frameworks

Criteria	Vue.js	React.js	Angular.js
Ease of use and learning	High	Medium	Low
Scalability and performance	High	High	High
Community and ecosystem	Large	Very Large	Large
Flexibility and customization	High	High	Medium
Compatibility with existing technologies	High	High	High
Support and updates	High	High	High
Maturity and stability	High	High	High
License and cost	Open Source	Open Source	Open Source

Source: Own elaboration

The table 5.2 presents a comparison of the three frameworks. While they all offer strong support, performance, and compatibility, we can see that there are differences in ease of use, learning speed, and flexibility. Vue.js is simple and easy to use, React.js has the largest community, Angular.js is more complex and has less flexibility than the other frameworks. I chose Vue.js because it is easier to use and takes the least amount of time to learn how to use it.

Thus, the resulting technology stack can be summarized as follows:

- Golang + GraphQL
- PostgreSQL
- Keycloak
- Vue.js + Vuestic



### 5.1.3 Design and layout

A crucial component of any system that interacts directly with users is the interface, which comprises the means and methods that facilitate interaction between system elements. This term is prevalent across various scientific and technological domains, referring to the interaction between any paired entities.

The software component of a distance learning system is a website featuring a graphical interface. When designing such interfaces, the concept of "usability" comes into play. Usability refers to the degree of convenience an interface offers for achieving its intended purpose. Numerous studies have been conducted on website interface development, and understanding and applying their findings requires identifying the fundamental structural elements of a site.

To provide a user-friendly experience, every website should incorporate the following components:

- **Site identification block:** This section of the graphical interface enables visitors to unmistakably recognize the resource they are using. It typically includes the site's logo, name, and possibly a brief description.
- **Hyperlink:** This is a portion of the document that links to another element (such as text, title, footnote, or image) within the document itself, another object (like a file, directory, or application) on a local computer or computer network, or elements of that object.
- **Navigation:** This interface element allows users to access specific structural parts (pages) of the site. Comprising main and additional menus, it consists of a collection of hyperlinks.
- **Content:** This encompasses the actual information presented on the site, which includes text and graphic data.

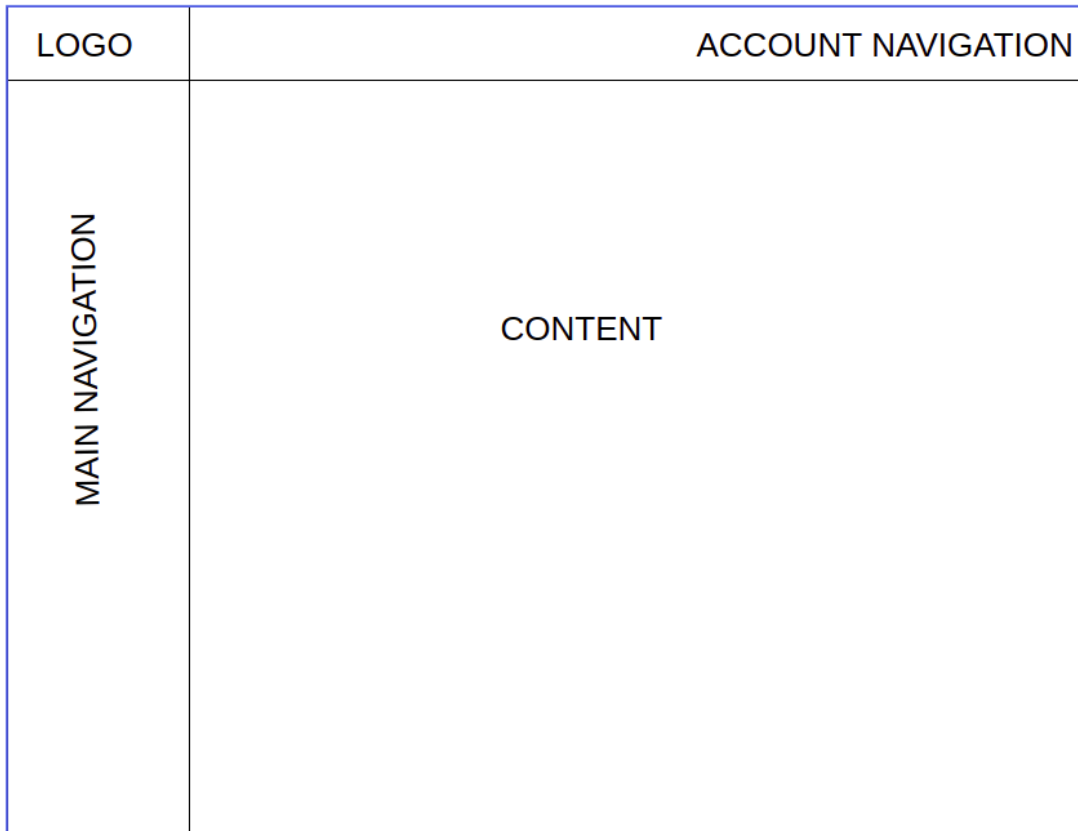


Figure 5.1: Interface structure  
Source: Own elaboration

The image 5.1 illustrates the layout of the application. On the left side, there is a primary menu featuring various navigation links, while the logo and account menu are situated at the top. The majority of the structure is dedicated to Content, ensuring user convenience. This structure can be observed by users or teachers who have successfully passed the login stage.

As depicted in Figure 5.1, the web application's structure necessitated the investigation of suitable Vue.js packages that would effectively address the required tasks. Through an extensive review, it was determined that Vuestic was the optimal package, owing to its comprehensive interface and diverse components. A demonstration of the interface, as implemented using the Vuestic package, can be observed in Figure 5.2.

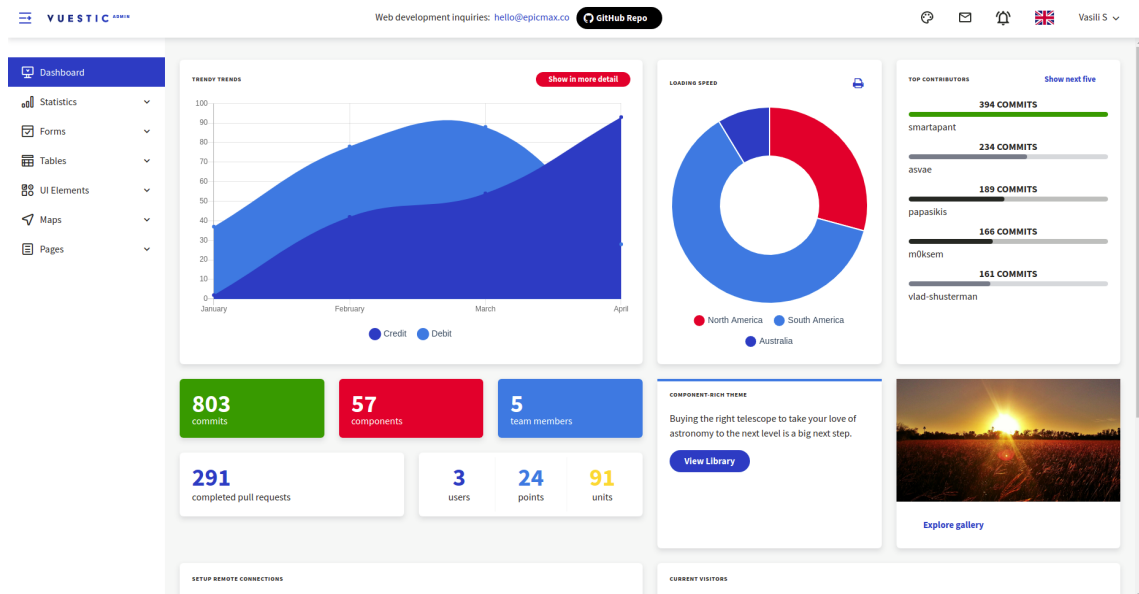


Figure 5.2: Interface demo  
 Source: <https://github.com/epicmaxco/vuestic-admin/>

### 5.1.4 Development process

The development of a web application involves several steps for each member of the development team. In the current project, the team consists of a single developer. The following sections outline the devised development plan and the corresponding steps undertaken:

- Database design and implementation
- Backend development using Golang and GraphQL
- Frontend development using Vue3 framework

The development steps detailed below provide a succinct overview of the primary stages involved in the process.

### Database design and implementation

The database constitutes an important component of any application, as it facilitates the storage and organization of data for efficient management. Postgres is a robust open-source relational database system that offers exceptional performance, reliability, and scalability. In this section, we will provide a concise overview of the database, emphasizing its key features. The database structure can be viewed in Figure 5.3.

Table 5.3: Database schema for LMS

Table name	Table description	Field name	Field description
instructors	Instructors table keep data about instructors	id	Primary key
		name	Instructor name
		email	Instructor email

Continued on next page

**Table 5.3 – continued from previous page**

<b>Table name</b>	<b>Table description</b>	<b>Field name</b>	<b>Field description</b>
		bio	Instructor bio
		created_at	Timestamp of record creation
courses	Courses table keeps data about courses	id	Primary key
		name	Course title
		description	Course description
		start_date	Course start date
		end_date	Course end date
		instructor_id	The primary key of the instructor associated with the current course
students	Students table keeps data about students	id	Primary key
		name	Student name
		email	Student email
groups	Group content assignments and study materials	id	Primary key
		name	Group name
		order_position	Position for every group in current course
		course_id	The primary key of the course associated with the current group
grading_categories	This table keeps weightage of every grading category	id	Primary key
		name	Title of grading category
		weightage	Weightage in percentage
		course_id	The primary key of the course associated with the current category
		order_position	Grading category order position
course_content	This table keeps records about study materials and assignments	id	Primary key
		name	Content name
		description	Content description
		due_date	Content due date
		content_type	Enum of content types
		is_published	Boolean, whether content is published
		order_position	Content order position
		group_id	Foreign key referencing groups(id)
		course_id	Foreign key referencing courses(id)
		grading_category_id	Foreign key referencing grading_categories(id)
submissions	This table keeps records of submitted assignments	id	Primary key
		material_id	Foreign key referencing course_content(id)
		student_id	Foreign key referencing students(id)
		submission_file	Submission file
		score	Submission score

Continued on next page

**Table 5.3 – continued from previous page**

Table name	Table description	Field name	Field description
		started_at	Timestamp of submission start
		completed_at	Timestamp of submission completion
		created_at	Timestamp of record creation
		updated_at	Timestamp of record update
student_courses	This table records enrolled students on the current course	student_id	Foreign key referencing students(id)
		course_id	Foreign key referencing courses(id)

Source: Own elaboration

Table 5.3 represents the visual structure of the database. However, it is essential to clarify the concept of `grade_category`. Essentially, each `grade_category` is associated with a specific category and has its own weight. To illustrate the calculation of the final grade, we will present the relevant formulas.

Let  $S_i$  be the submission score for a student's  $i$ -th submission,  $W_j$  be the weightage of the  $j$ -th grading category, and  $G_j$  be the set of submissions belonging to the  $j$ -th grading category.

First, for each grading category  $j$ , calculate the weighted sum of scores in that category:

$$\text{WeightedSum}_j = \sum_{i \in G_j} S_i \times W_j \quad (5.1)$$

Next, calculate the final grade by summing the weighted sums for all grading categories:

$$\text{FinalGrade} = \sum_j \text{WeightedSum}_j \quad (5.2)$$

To compute the final grade as a percentage, divide the final grade by the sum of the maximum possible weighted scores in each category:

$$\text{FinalGradePercentage} = \frac{\text{FinalGrade}}{\sum_j (\text{MaxPossibleScore}_j \times W_j)} \times 100 \quad (5.3)$$

You can view a visual representation of the database in TablePlus program by referring to Figure 5.3.

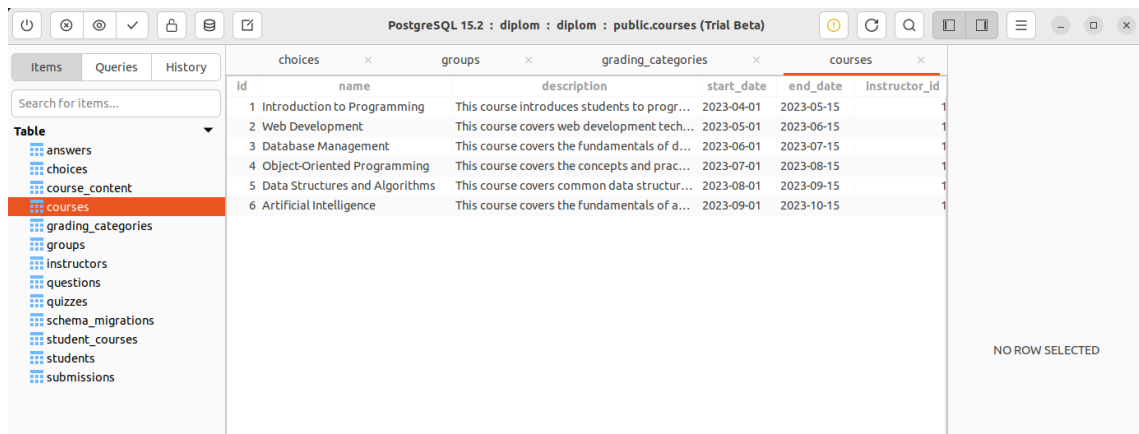


Figure 5.3: Database view in TablePlus  
Source: Own elaboration

## Backend development

The development of the backend involves various essential aspects that are equally important. However, in this section, the focus will be on the functionality rather than the development process. Therefore, some significant steps may be omitted, but an overview of the backend architecture will be provided.

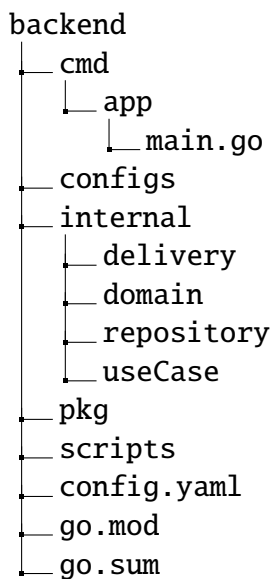


Figure 5.4: Folder backend structure for LMS system  
Source: Own elaboration

Clean architecture is a software design philosophy that emphasizes separation of concerns, modularity, and maintainability. In figure 5.4, the folder structure reflects the clean architecture principles:

1. **backend**: The root folder of the project.
2. **cmd**: This folder contains the entry point of the application (e.g., `main.go`). The `app` subfolder holds the main application file, which initializes and starts the application.
3. **configs**: This folder holds configuration files and other resources required to configure

the application.

4. **internal**: This folder contains the main components of the clean architecture, divided into subfolders:
  - a. **delivery**: Handles the interaction with external systems, such as user input, API requests, or file I/O. It is responsible for delivering data between the system's components and external sources.
  - b. **domain**: Contains the core business logic and domain models of the application. It defines the entities, value objects, and rules that represent the problem domain.
  - c. **repository**: Provides a layer of abstraction for data storage and retrieval. It manages interactions with the data source, such as a database, file system, or external API.
  - d. **useCase**: Represents the application's use cases and orchestrates the flow of data between the delivery, domain, and repository layers.
5. **pkg**: This folder contains reusable utility packages and libraries that can be shared across multiple projects or components.
6. **scripts**: Holds scripts and other tools needed for tasks like building, deploying, or testing the application.
7. **config.yaml**: The main configuration file for the application, containing settings and parameters.
8. **go.mod** and **go.sum**: Go module files that manage dependencies and ensure reproducible builds.

A visual representation of the backend architecture can be viewed in Visual Studio Code by referring to Figure 5.5.

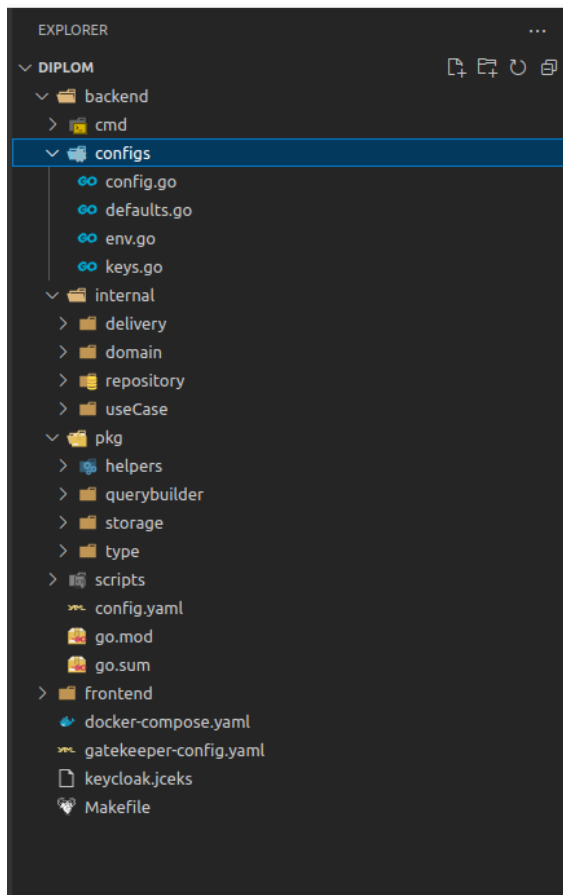


Figure 5.5: Backend structure view in Visual Studio Code  
Source: Own elaboration

By following the clean architecture principles and organizing your project into these folders, we create a maintainable, scalable, and modular system that is easy to understand and modify as the project evolves.

### **Frontend development**

The architecture of the frontend is much simpler because all the folders were created by the developers of the Vuestic package. In any case, some modifications in the folder structure were required. On the figure 5.6 is the structure of the frontend folder.



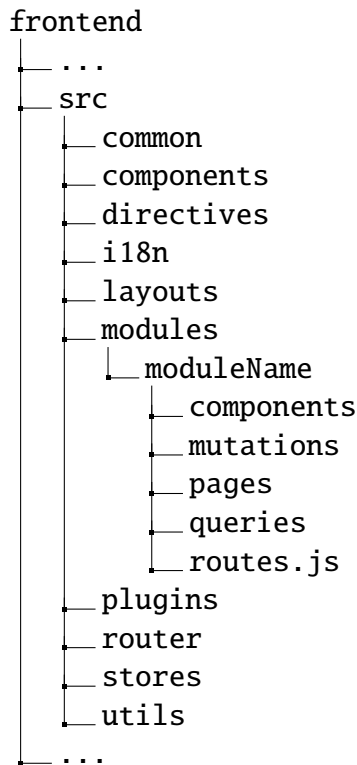


Figure 5.6: Folder frontend structure for LMS system

Source: Own elaboration

The folder structure of your Vue.js + Vuestic package of LMS project is organized as follows:

1. **frontend**: The root folder of the project.
2. **src**: This folder contains the main source code of the application, divided into sub-folders:
  - a. **common**: Holds shared utilities, constants, and other common resources used across the application.
  - b. **components**: Contains reusable Vue components that can be used in multiple parts of the application.
  - c. **directives**: Stores custom Vue directives that provide additional functionality to the components.
  - d. **i18n**: Manages internationalization and localization, including translation files for different languages.
  - e. **layouts**: Holds the layout components that define the overall structure and appearance of the application.
  - f. **modules**: Organizes the application's features into separate modules. Each module has its own folder with the following structure:
    - i. **components**: Components that belong to the current module.
    - ii. **mutations**: GraphQL Mutation Functions.

- iii. `pages`: Pages that belong to the current module.
  - iv. `queries`: GraphQL Queries Functions.
  - v. `routes.js`: All routes in current module.
  - g. `plugins`: Contains Vue plugins that extend the application's functionality or integrate with external libraries.
  - h. `router`: Manages the application's routing configuration and navigation.
  - i. `stores`: Holds Vuex stores for managing the application's global state.
  - j. `utils`: Contains utility functions and other helper code.
3. Other folders and files not specified are related to the build process, configuration, or testing, such as `node_modules`, `package.json`, and `.gitignore`.

A visual representation of the frontend architecture can be viewed in Visual Studio Code by referring to Figure 5.7.

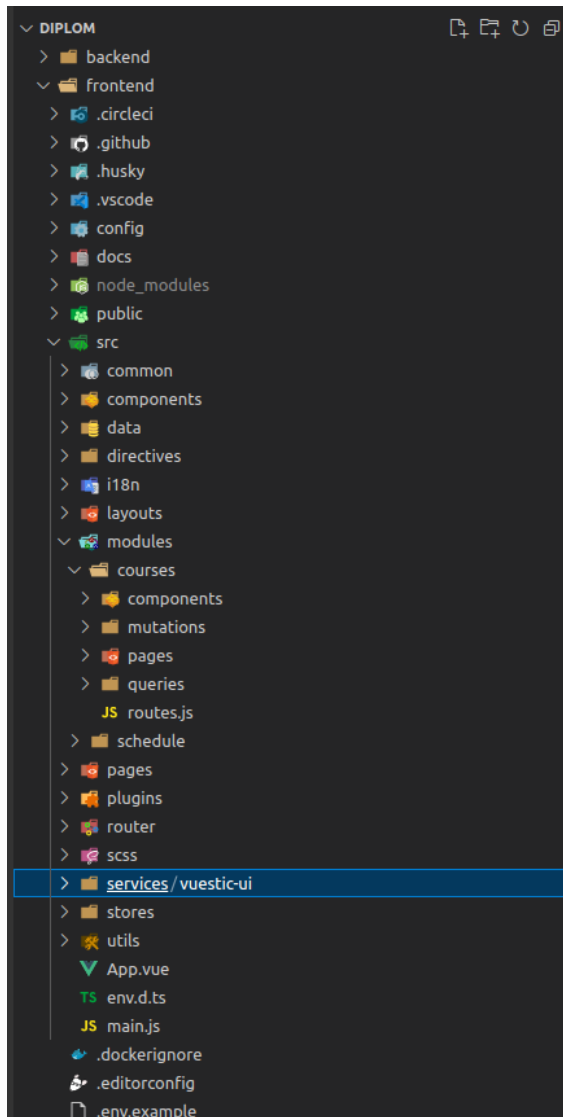


Figure 5.7: Frontend structure view in Visual Studio Code  
Source: Own elaboration

## 5.2 Functionality Presentation

### 5.2.1 Introducing the Web Application Features

In this section, we will explore all the features of the LMS application that we have developed. Although some features are similar from both the student's and instructor's views, we will provide both views in some sections.

#### Authorization

We have previously mentioned in Table 5.1 that both user roles require authorization. Authentication and authorization can be implemented in various ways, but for this project, we have opted for Keycloak. Keycloak is an open-source identity and access management solution that offers authentication and authorization services for web, mobile applications, and services. It is widely used, has extensive documentation, and a large community.

Using Keycloak in an LMS can provide numerous advantages, such as:

- **Centralized User Management:** Keycloak allows for the centralized management of user accounts, groups, and permissions. This means that user addition, updates, and removal, as well as role and permission assignment can be done from one central location, without the need for manual updates in each application.
- **Single Sign-On (SSO):** Keycloak provides SSO capabilities, enabling users to log in only once to access multiple applications. This feature enhances user convenience while improving security by reducing the number of login credentials they need to remember.
- **Security:** Keycloak provides a range of security features, such as two-factor authentication, password policies, and social authentication, to ensure that only authorized users can access the LMS system.
- **Integration:** Keycloak can be easily integrated with other applications, including LMS systems, to provide seamless authentication and authorization services.

A visual representation of the Keycloak admin panel, which enables the management of users, can be seen in Figure 5.8

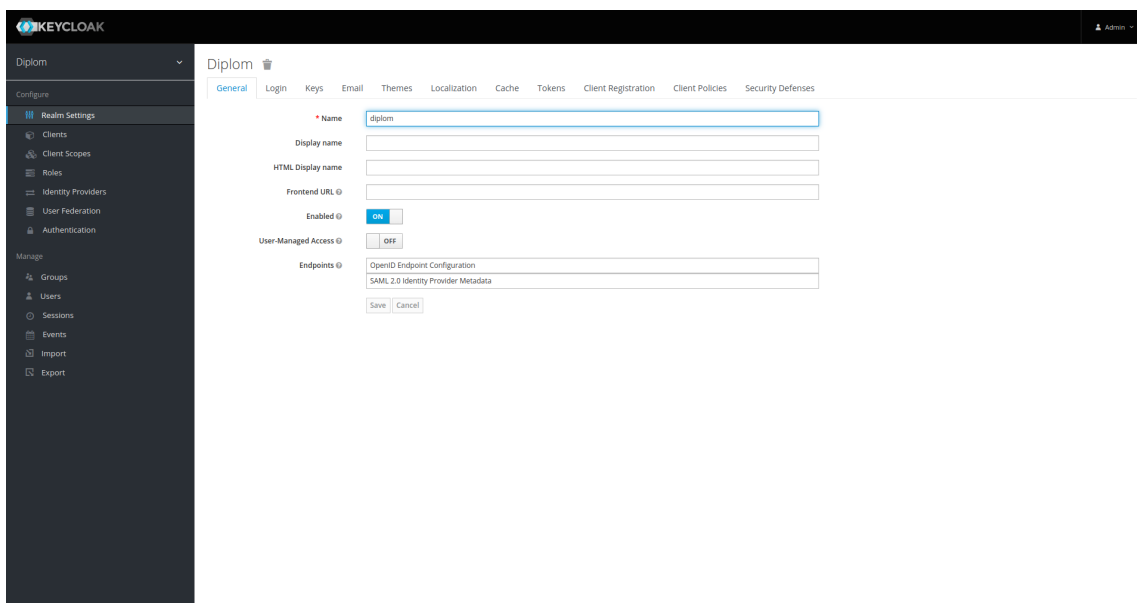


Figure 5.8: Admin panel in Keycloak  
Source: Own elaboration

Access to the main page of the LMS is prevented by Keycloak until the user is authorized. Figure 5.9 shows the authorization screen.

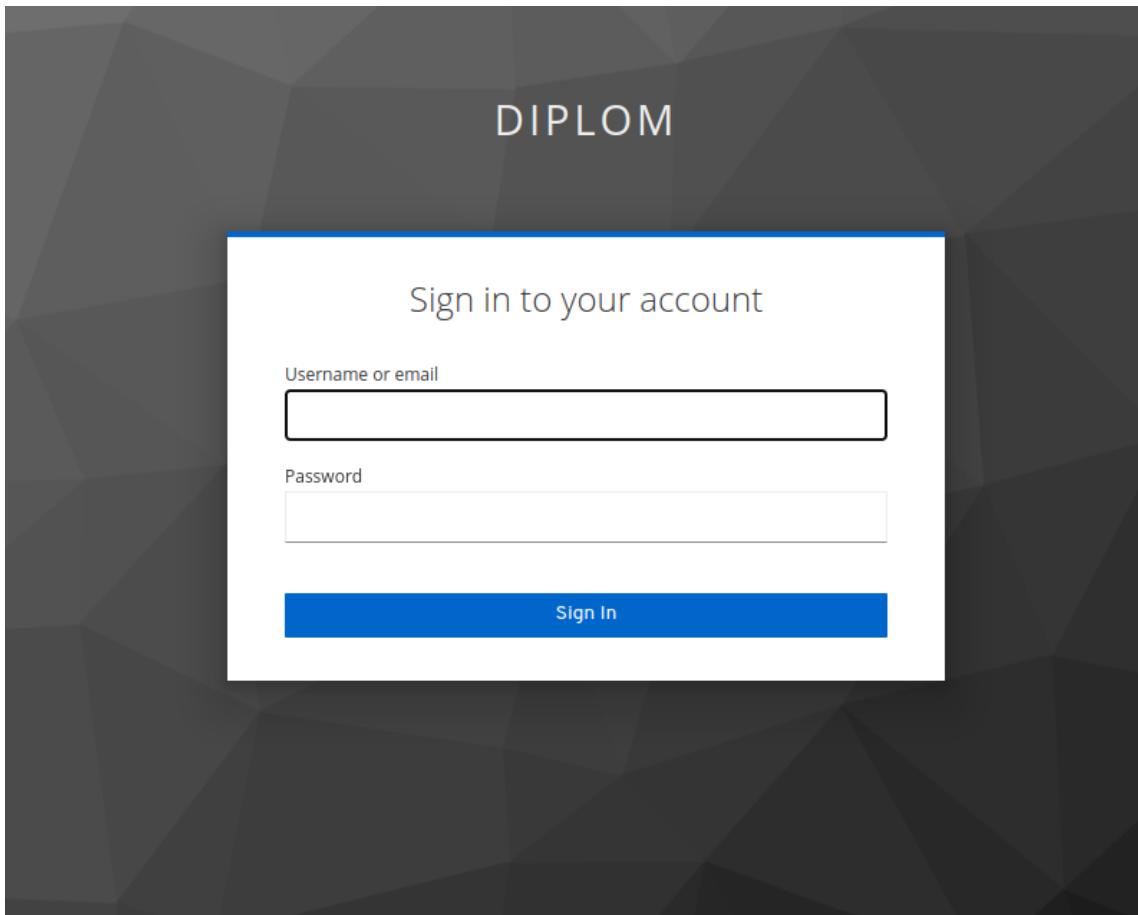


Figure 5.9: Keycloak authorization page  
Source: Own elaboration

## Course Management

As described in Table 5.1, the instructor is responsible for managing the course. This includes creating, editing, and deleting courses. To begin, let's take a look at what the basic course page looks like for a teacher in Figure 5.10.

As you can see, here are the courses the current instructor is teaching. If a student logs in, he will see almost the same page with the courses in which he was enrolled. The only difference is what actions the instructor can perform and, of course, the student cannot. The student will not be able to see and interact with the buttons at the bottom of each course card and course creation, which are a blue dotted frame with a plus sign inside.

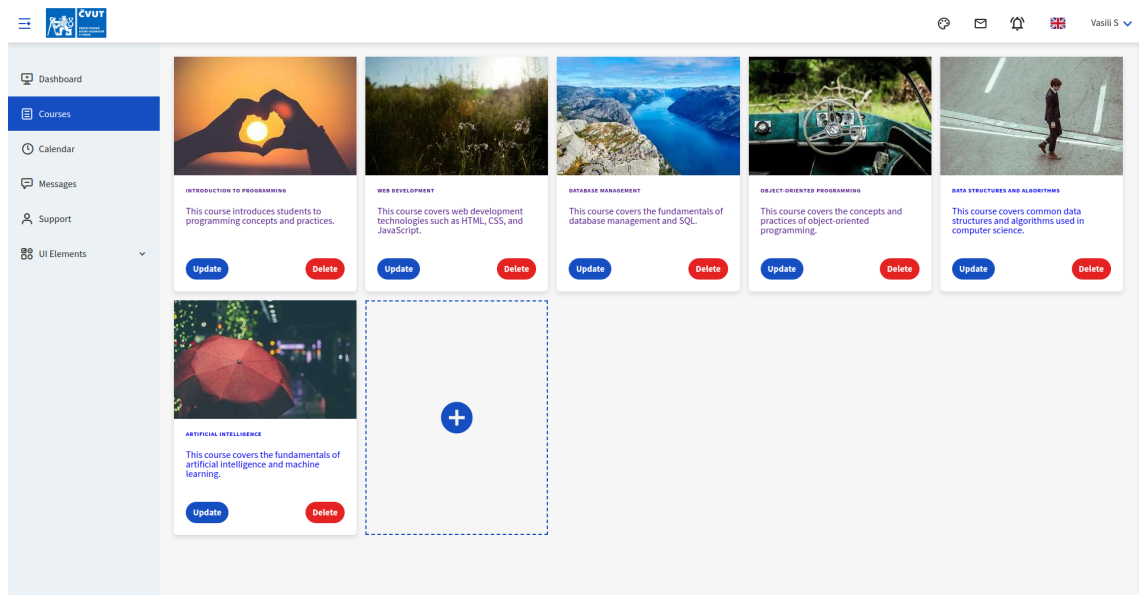


Figure 5.10: Page of all courses. Teacher view

Source: Own elaboration

The update and creation process can be seen in figures 5.11 and 5.12, which show the modal windows used for these actions. To update a course, click on the "update" button for the course you want to edit, and to create a new course, click on the dashed-bordered box with the plus icon. There are five labeled fields that need to be edited or filled in to add or update the course information. Here is a description of each of them:

- **Course title:** A text input field for entering the course title.
- **Course description:** A textarea input field for providing a detailed description of the course.
- **Course starts at:** A date input field for specifying the start date of the course.
- **Course ends at:** A date input field for specifying the end date of the course.
- **Enrolled students:** A multiple selection dropdown menu for choosing the students enrolled in the course. Each selected student is displayed as a closeable chip.

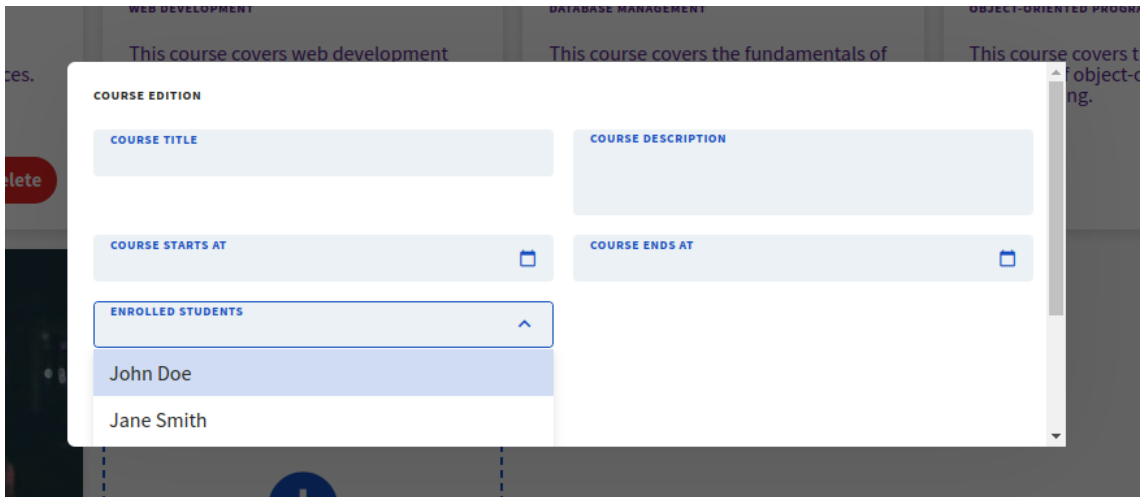


Figure 5.11: Course creation process  
Source: Own elaboration

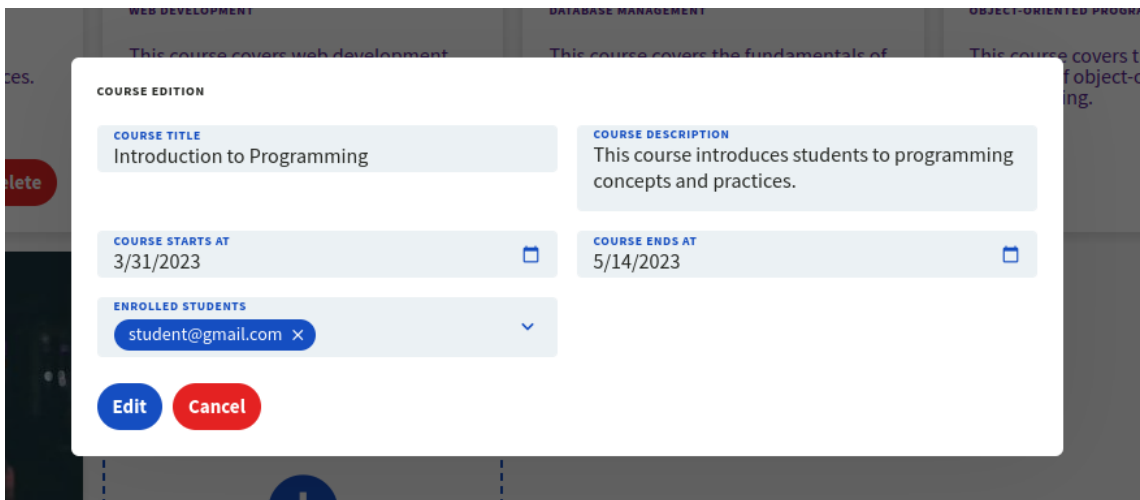


Figure 5.12: Course updation process  
Source: Own elaboration

### Material and Assignment Management.

In the previous subsection, we covered course management. When a course is clicked, the user is redirected to the modules page, which displays a small sidebar menu. The menu consists of links as shown in Table 5.4.

Table 5.4: Course Pages and Descriptions

Page	Description
Home	Home page with course title, description, and instructor's contact information
Modules	Page with study materials, and assignments; teachers can create and organize content
Assignments	Page displaying assignments separated by groups like "Upcoming Assignments" and "Past Assignments"
Grading	Page for checking real-time grades; teachers can create grading categories and organize content

Source: Own elaboration

In Figure 5.13, the "Modules" page displays all learning materials and assignments for the current course. The instructor can choose to create and organize these materials either all at once or on a daily basis. In this example, the course content is divided into weeks, but the organization can vary depending on the instructor's preference. The title groups can represent a wide range of categories, such as topics, introductory materials, study tips, or content by month.

Materials can be either published or unpublished. Unpublished materials remain hidden from students, providing flexibility for instructors and the opportunity to plan course content in advance. A green check mark indicates that the material is published and accessible to students.

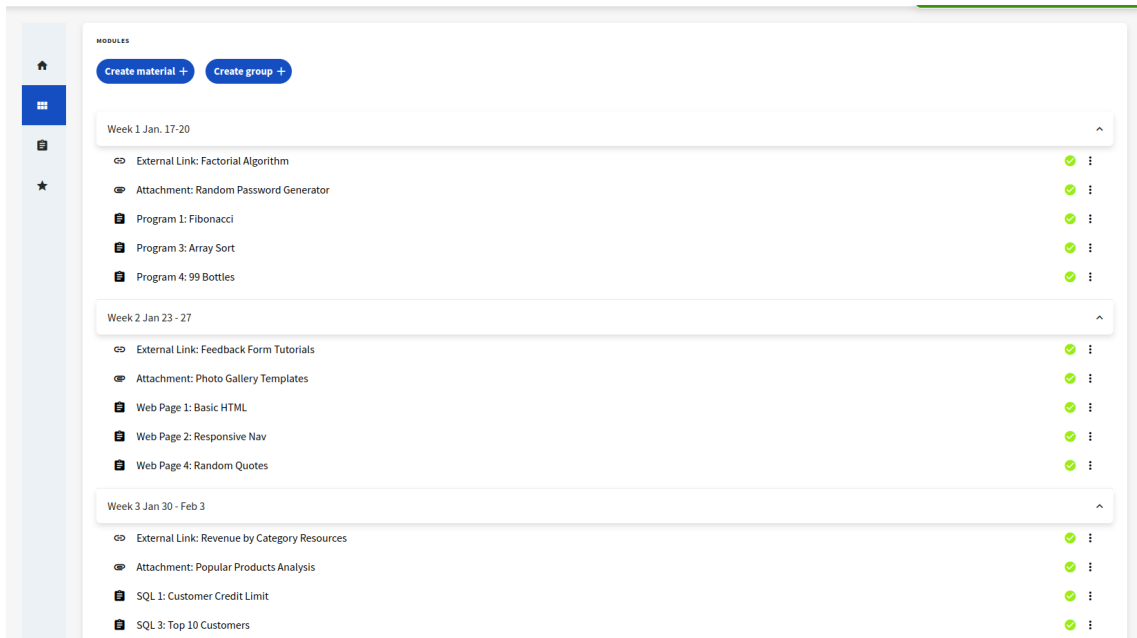


Figure 5.13: Modules page. Teacher view.

Source: Own elaboration

On the other side of the material title, there are three dots that provide the instructor with options to edit or delete the material or assignment. It is important to note that instructors can easily rearrange materials and groups using the drag-and-drop functionality. This feature allows them to move materials between groups, ensuring an organized and



adaptable course structure.

The creation of study material or any kind of course content is both easy and straightforward. Several types of content have been selected for students to access or submit for evaluation. These types include External link, Attachment, Page and Assignment. Let's briefly overview each type:

**External link** - Students can see the title and description of the study material, along with a button that redirects them to an external source for further exploration. **Attachment** - With this content type, students can view the title and description of the study material and download the attached file. **Page** - In this type, instructors can create a title and description containing information and embed links, such as YouTube videos, within the content. **Assignment** - This is a task that students must complete within a specified time frame. The submission type for the assignment can be On paper, Online, or through an External tool. Figure 5.14 provides an example of assignment creation.

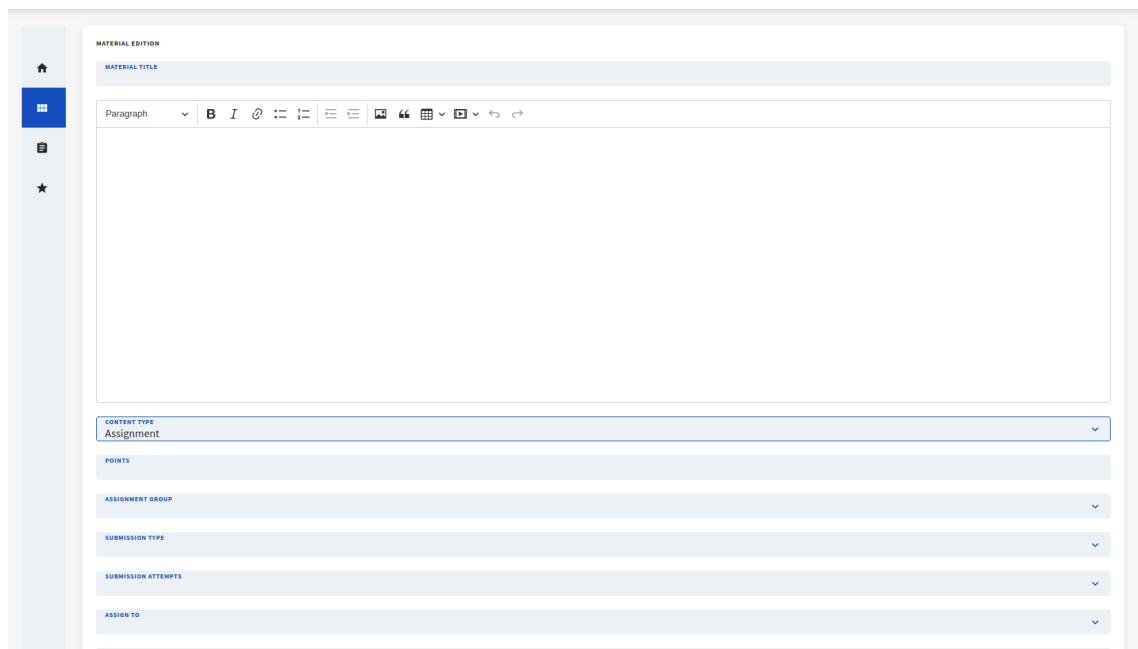
The image shows a screenshot of a web application interface for creating study material. The main area is a rich-text editor with a toolbar containing options for Paragraph, Bold (B), Italic (I), Link, Unlink, Bulleted List, Numbered List, Indent, Outdent, Undo, and Redo. Below the editor, there are several configuration fields: 'CONTENT TYPE' is set to 'Assignment'; 'POINTS' is a text input field; 'ASSIGNMENT GROUP' is a dropdown menu; 'SUBMISSION TYPE' is a dropdown menu; 'SUBMISSION ATTEMPTS' is a dropdown menu; and 'ASSIGN TO' is a dropdown menu. A 'START DATE' field is partially visible at the bottom.

Figure 5.14: Creation of study material.

Source: Own elaboration

All the fields for each type are listed below:

**Material Title** The title of the material being created or edited.

**Content Type** The type of the material (e.g., External link, Attachment, Page, Assignment).

**Description** A rich-text editor for creating or editing the material's description.

**Attachment-specific fields:**

- Upload: This field is used for document uploading.

**External link-specific fields:**

- **Link:** The link to which students will be redirected.

### Assignment-specific fields:

- **Points:** The number of points the assignment is worth.
- **Assignment Group:** The group to which the assignment belongs.
- **Submission Type:** The type of submission accepted for the assignment (e.g., Online, On Paper, External Tool).
- **Submission Attempts:** The number of allowed submission attempts for the assignment.
- **Assign To:** The group of users the assignment is assigned to (e.g., Everyone).
- **Assignment starts at:** The time when students can start doing the assignment.
- **Assignment ends at:** The time when the assignment should be completed.

Right after any study material is created and published by the instructor, students can view it on their module page with the course materials. An example of a material with type assignment can be seen in Figure 5.15.

ASSIGNMENT TILL 2023-05-06

## Program 4: 99 Bottles

This assignment should be submitted before: **2023-05-06**

The **Program 4: 99 Bottles** assignment requires you to create a program that generates the lyrics for the well-known song, "99 Bottles of Beer on the Wall." The goal of this assignment is to practice programming concepts such as loops, conditional statements, and string manipulation.

The song's lyrics follow a specific pattern that counts down from 99 bottles of beer on the wall to no bottles left. Your program should output the complete lyrics without any manual intervention. Below is the pattern your program needs to follow:

- Start with the number 99.
- For each number from 99 to 1, display the following verses (replace *n* with the current number):  
`n bottles of beer on the wall, n bottles of beer. Take one down, pass it around, n-1 bottles of beer on the wall.`
- When you reach the last verse (1 bottle of beer on the wall), display the following lines:  
`1 bottle of beer on the wall, 1 bottle of beer. Take one down, pass it around, no more bottles of beer on the wall.`
- Finally, display the closing verse:  
`No more bottles of beer on the wall, no more bottles of beer. Go to the store and buy some more, 99 bottles of beer on the wall.`

**Requirements:**

1. Your program should be written in the language specified by your instructor.
2. Use a loop to iterate through the numbers from 99 to 1.
3. Use conditional statements to handle the special cases (1 bottle and no more bottles).
4. Your program should display the lyrics correctly without any spelling or formatting errors.

**Submission:** Please submit your source code file and a screenshot of the program's output.

Drop files here to upload [Upload file](#)

[Submit](#)

Figure 5.15: Assignment. Student View.  
Source: Own elaboration

The views for study materials differ slightly between instructors and students. Instructors have additional actions available to them, such as editing, deleting, and publishing/unpublishing.

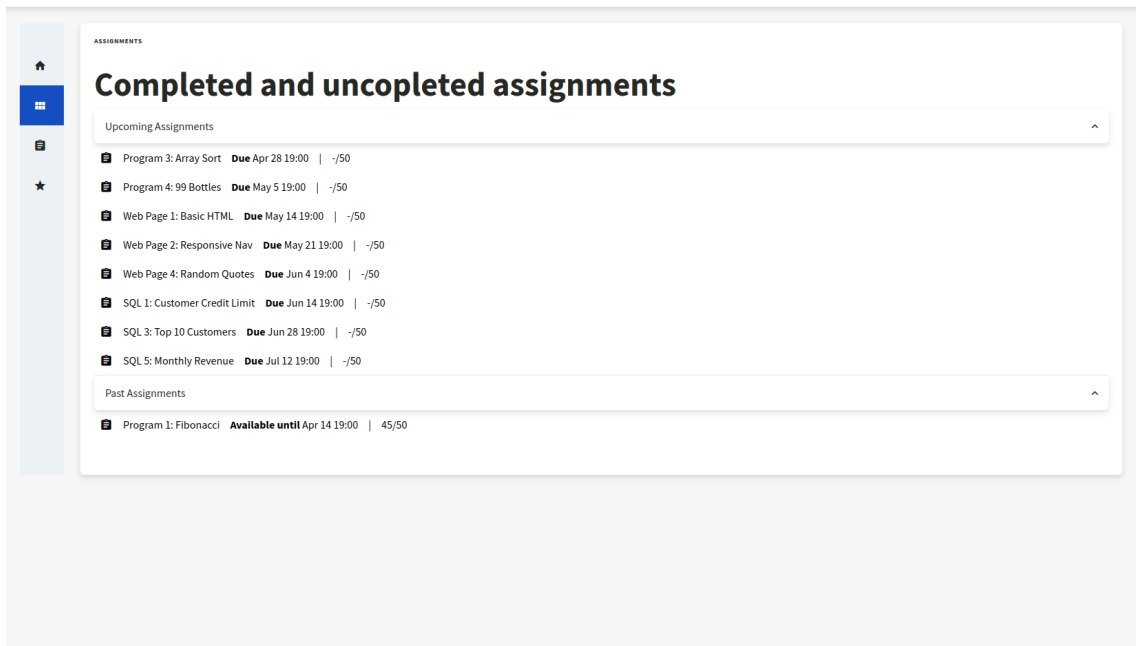


Figure 5.16: Upcoming/Past assignments. Student View.  
Source: Own elaboration

In Table 5.4, the "Assignments" page is primarily designed for students rather than instructors. This page displays assignments separated into upcoming and past categories, providing students with an easy way to track their deadlines and review the point values for each assignment. This organization offers students greater flexibility in managing and staying on top of their progress. A sample view of the "Assignment" page can be seen in Figure 5.16.

The Grading page serves a vital role in managing the evaluation process for both instructors and students, with each group having access to unique features tailored to their needs. For instructors, the Grading page is a powerful tool that enables them to efficiently create and organize grading groups, as well as manage the assignments associated with these groups. This organizational flexibility empowers instructors to design a balanced evaluation system, ensuring that students are assessed fairly across various aspects of the course.

By utilizing the Grading page, instructors can quickly and easily adjust the distribution of assignments within each grading group. This may be necessary to accommodate changes in course material, assessment strategies, or student performance trends. The Grading page also allows instructors to monitor the overall progress of the class, making it easier to identify and address any areas that may require additional attention. A sample view of the "Grading" page for teachers can be seen in Figure 5.17.

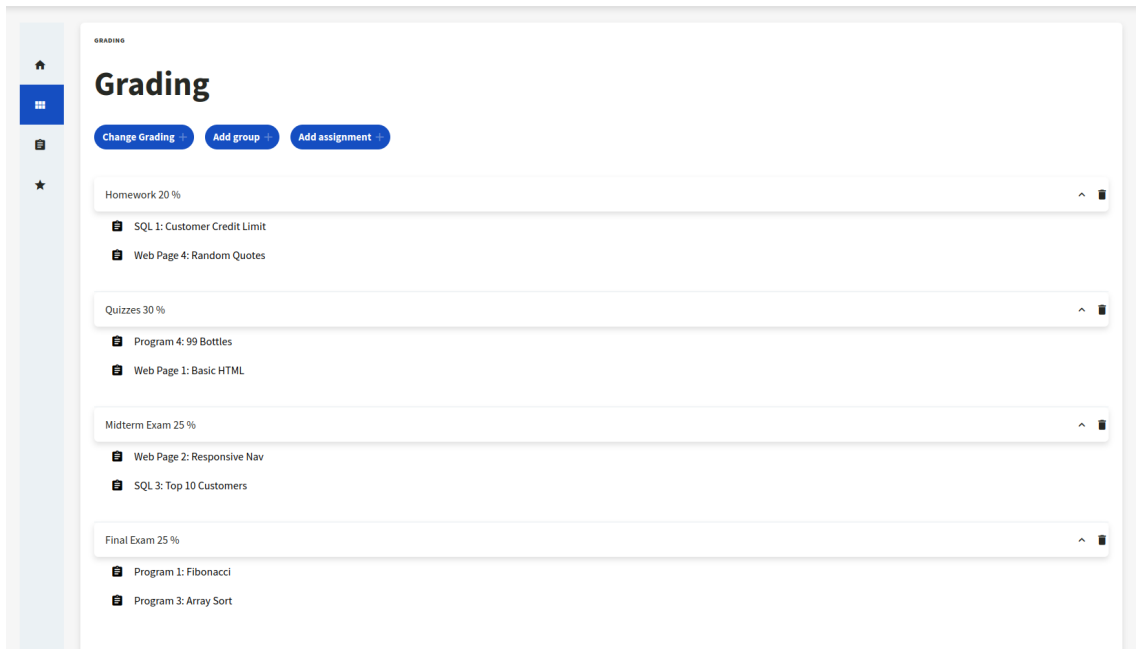


Figure 5.17: Grading page. Teacher View.  
Source: Own elaboration

A more detailed explanation of the Grading page functionalities, particularly the process of calculating final grades based on the grading groups, can be found in a previous section of this document. The section includes relevant formulas 5.1, 5.2 and 5.3, illustrating evaluating student performance effectively.

### **Schedule.**

Our application also incorporates an intuitive calendar feature, which significantly enhances the overall experience for both teachers and students. The calendar function serves as a centralized hub, providing an overview of upcoming assignments, deadlines, tests, and other important events. This feature is specifically designed to streamline the organization and planning process for all users.

Teachers can greatly benefit from this feature, as it allows them to keep track of their courses' upcoming assignments and tests. By having a clear view of the upcoming events, instructors can allocate their time more effectively and prepare themselves more thoroughly for the questions and topics that will be addressed. This, in turn, helps to ensure that they can provide the best possible support to their students.

For students, the calendar feature is an indispensable tool for staying informed and managing their time efficiently. By having access to an up-to-date overview of their assignments and deadlines, students can prioritize their workload and allocate their time accordingly. This empowers them to balance their academic responsibilities with other aspects of their lives, such as extracurricular activities, part-time jobs, and social engagements. The calendar feature can be viewed in Figure 5.18, as illustrated below.

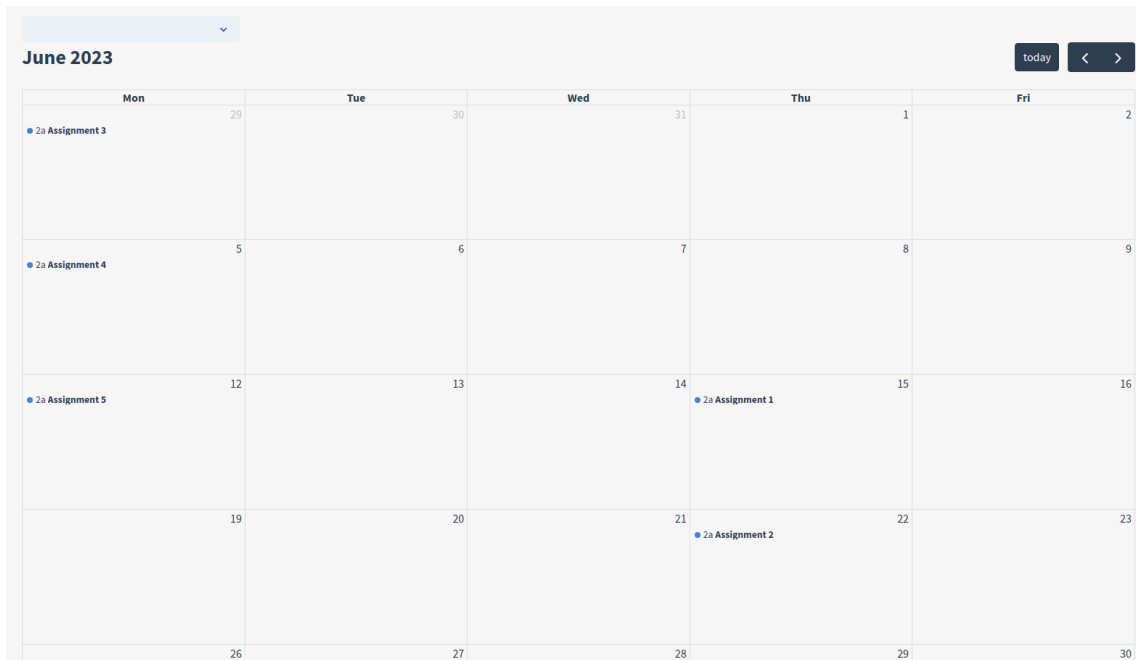


Figure 5.18: Schedule. Student View.

Source: Own elaboration

An additional aspect of the calendar feature, as shown in Figure 5.18, is the presence of a filter located in the upper left corner. This filter proves to be highly beneficial for both students and teachers, as it allows them to easily narrow down and view assignments pertaining to a specific course. By applying the filter, users can eliminate unnecessary information from the calendar and concentrate solely on the individual subject of interest. This helps to streamline the process of tracking assignments and managing their schedules more efficiently.

### 5.3 Ideas for further development

The potential for growth and enhancement of this application is virtually limitless. As it currently represents just the initial stage of development, there are many essential and supplementary features yet to be incorporated. Here are a few suggestions for further development and improvement:

1. **Grading Criteria:** Implement a system under the headings that enables instructors to establish specific criteria for evaluating students' work, ensuring a more transparent and consistent grading process.
2. **Comments:** Facilitating communication between teachers and students, comments on various aspects of assignments can help clarify any misunderstandings and provide valuable feedback for improvement.
3. **Announcements:** The creation of a mailing list for each course would serve as a highly effective and convenient tool for instructors to relay important information to their students in a timely manner.
4. **Calendar Enhancements:** Expand the calendar's functionality by allowing all users to add personal tasks, thus enabling them to maintain a comprehensive to-do

list that combines both academic assignments and individual responsibilities.

These suggestions represent just a fraction of the numerous possibilities for refining and expanding the application, depending on the specific requirements and capabilities of the platform. Continual development and innovation will ensure that the app remains relevant and valuable to its users in the ever-evolving landscape of education.

## **5.4 Evaluating Project Cost and Duration of a CTU System Using Microsoft Project**

In this chapter, we will delve into the process of estimating the time and cost required for creating a tailor-made LMS system for CTU University by leveraging the diverse functionalities of Microsoft Project. This robust and adaptable software facilitates the seamless organization and execution of projects, while also offering an extensive selection of features that cater to different project management needs. Our primary goal in this analysis is to gain a holistic perspective on the approximate duration and financial investment necessary to bring this custom LMS project to fruition. By doing so, we aim to provide CTU University with valuable insights that will aid in their decision-making process, ensuring that they make the most informed choice when it comes to selecting the best LMS solution for their institution.

### **5.4.1 Collecting preliminary data**

To begin working with Microsoft Project, specific information is required to ensure that our analysis is both accurate and comprehensive. For our current objectives, we will need to gather the following data: the project's start date, a detailed table outlining the composition of the development team, including their respective hourly pay rates, and a well-structured table enumerating the various project phases and corresponding activities. By collecting and organizing this essential data, we will be better equipped to carry out an in-depth evaluation of the project using Microsoft Project's extensive capabilities.

The project's commencement date has been set for January 2, 2024. Following this decision, the next crucial step is assembling a proficient development team to drive the project forward. The team composition was determined to include a diverse array of specialists, such as a Project Manager, Designer, two Backend Developers, and two Frontend Developers.

The Project Manager will be responsible for making a project plan, determining its timing and phases, working with the rest of the team, and so on. The designer will implement the UX/UI design that meets all the necessary requirements of the project and make all the necessary layouts for development. Backend developers will be responsible for business logic and data storage of the application. Front-end developers will translate all layouts and design elements into code and link it to the backend via APIs.

Through diligent research on job search websites such as Glassdoor.com and Jobs.cz, we have determined the average salary for each member of our development team based in Prague. It is important to acknowledge that an individual's salary is influenced by various factors, including their experience, technical proficiency, job requirements, and numerous other aspects. The hourly rate was computed as the mean of the average rates across all jobs where limits were established. Detailed information about the project team's

composition and associated salaries can be found in Table 5.5.

Table 5.5: Team members and their hourly rates

Profession	Amount	Hourly rate
Project manager	1	\$32/hr
UX/UI designer	1	\$30/hr
Frontend developer	2	\$33/hr
Backend developer	2	\$38/hr

Source: Own elaboration

It is important to take into account the work schedule, weekends, and public holidays in the Czech Republic when planning the project timeline. Each team member works a standard workday from 8:00 to 17:00, with a one-hour lunch break between 12:00 and 13:00. Weekends typically fall on Saturdays and Sundays, and the project schedule should also account for national holidays observed in the Czech Republic. A comprehensive list of these holidays can be found in Table 5.6.

Table 5.6: National celebration days in the Czech Republic

Celebration Day	Start Date	End Date
New Year's Day	January 1	January 1
Easter Monday	Varies	
Labor Day	May 1	May 1
Liberation Day	May 8	May 8
Saints Cyril and Methodius Day	July 5	July 5
Jan Hus Day	July 6	July 6
Czech Statehood Day	September 28	September 28
Independent Czechoslovak State Day	October 28	October 28
Struggle for Freedom and Democracy Day	November 17	November 17
Christmas Eve	December 24	December 24
Christmas Day	December 25	December 25
St. Stephen's Day (Boxing Day)	December 26	December 26

Source: Own elaboration

The subsequent step involves outlining the project activity table. This project will comprise four key phases: Planning Phase, Design Phase, Backend Development Phase, and Frontend Development Phase. Each phase will encompass a variety of activities. The table will detail the activity name, duration, and predecessors.

Predecessors refer to tasks that precede a specific task, while successors are tasks that follow it. This distinction enables project managers to effectively plan, manage, and track a project's progress, ensuring that tasks are executed in the proper sequence and resources are allocated optimally. Predecessors can be classified based on task dependencies into:

- **Finish-to-start (FS):** The most prevalent dependency type, where a task must be completed before its successor can commence.
- **Start-to-start (SS):** Both the predecessor and successor tasks must begin simultaneously.

- **Finish-to-finish (FF):** Both the predecessor and successor tasks must conclude at the same time.
- **Start-to-finish (SF):** The predecessor task must initiate before the successor task can conclude.

In this project, we will utilize the FS dependency type. A comprehensive table of activities can be found in Table 5.7.

Table 5.7: Project activities

No.	Activity Name	Duration (Days)	Predecessors
1	<b>Planning Phase</b>		
1.1	Define project scope	5	
1.2	Identify stakeholders	3	1.1
1.3	Develop project charter	7	1.1
1.4	Create work breakdown structure	5	1.3
1.5	Develop project schedule	5	1.4
1.6	Plan resources	3	1.4
2	<b>Design Phase</b>		
2.1	Develop visual design concept	7	1.5
2.2	Create user interface (UI) mockups	10	2.1
2.3	Design UI elements (buttons, icons, etc.)	5	2.2
2.4	Design layout for various screens	10	2.2
2.5	Review and approve UI mockups	5	2.2
2.6	Review and approve UI elements	3	2.3
2.7	Review and approve screen layouts	5	2.4
2.8	Finalize visual design documentation	5	2.5, 2.6, 2.7
3	<b>Backend Development Phase</b>		
3.1	Plan backend architecture	5	2.8
3.2	Develop database schema	7	3.1
3.3	Set up development environment	3	3.1
3.4	Develop API endpoints	15	3.3
3.5	Implement authentication & authorization	7	3.3
3.6	Develop business logic	20	3.3
3.7	Integrate database with API	5	3.2, 3.4
3.8	Unit testing for backend components	10	3.5, 3.6, 3.7
3.9	Backend integration testing	7	3.8
4	<b>Frontend Development Phase</b>		
4.1	Plan frontend architecture	5	2.8
4.2	Set up frontend development environment	3	4.1
4.3	Develop UI components	15	4.2, 2.8

*Continued on next page*



Table 5.7 – Continued from previous page

No.	Activity Name	Duration (Days)	Predecessors
4.4	Integrate API with frontend	10	3.4, 4.2
4.5	Implement frontend routing & navigation	7	4.2
4.6	Implement responsive design	10	4.2
4.7	Unit testing for frontend components	10	4.3, 4.4, 4.5, 4.6
4.8	Frontend integration testing	7	4.7
<b>5</b>	<b>Deployment</b>		
5.1	Prepare deployment environment	5	3.9, 4.8
5.2	Deploy to staging environment	2	5.1
5.3	Conduct final testing	5	5.2
5.4	Deploy to production environment	2	5.3
5.5	Monitor and maintain system		5.4

Source: Own elaboration

It should be noted that Table 5.7 was compiled based on the author's personal experience in web application development.

Upon gathering all the necessary data, we can proceed to utilize MS Project for managing the project's timeline and its various phases. This will enable us to establish the overall project duration, the duration of each phase, the total project cost, and the cost associated with each phase.

#### 5.4.2 Assessing Project Duration

In Section 5.4.1, we outlined the data necessary for constructing a project plan in MS Project. In this section, we will determine the project's overall timeline, as well as the time frame for each individual phase. To begin, we must first configure the project settings, which includes establishing the project's start date and accounting for all holidays in the Czech Republic. Referring to Table 5.6, we can incorporate this information into our project plan. A visual representation of holidays integrated into the MS Project can be seen in Figure 5.19.

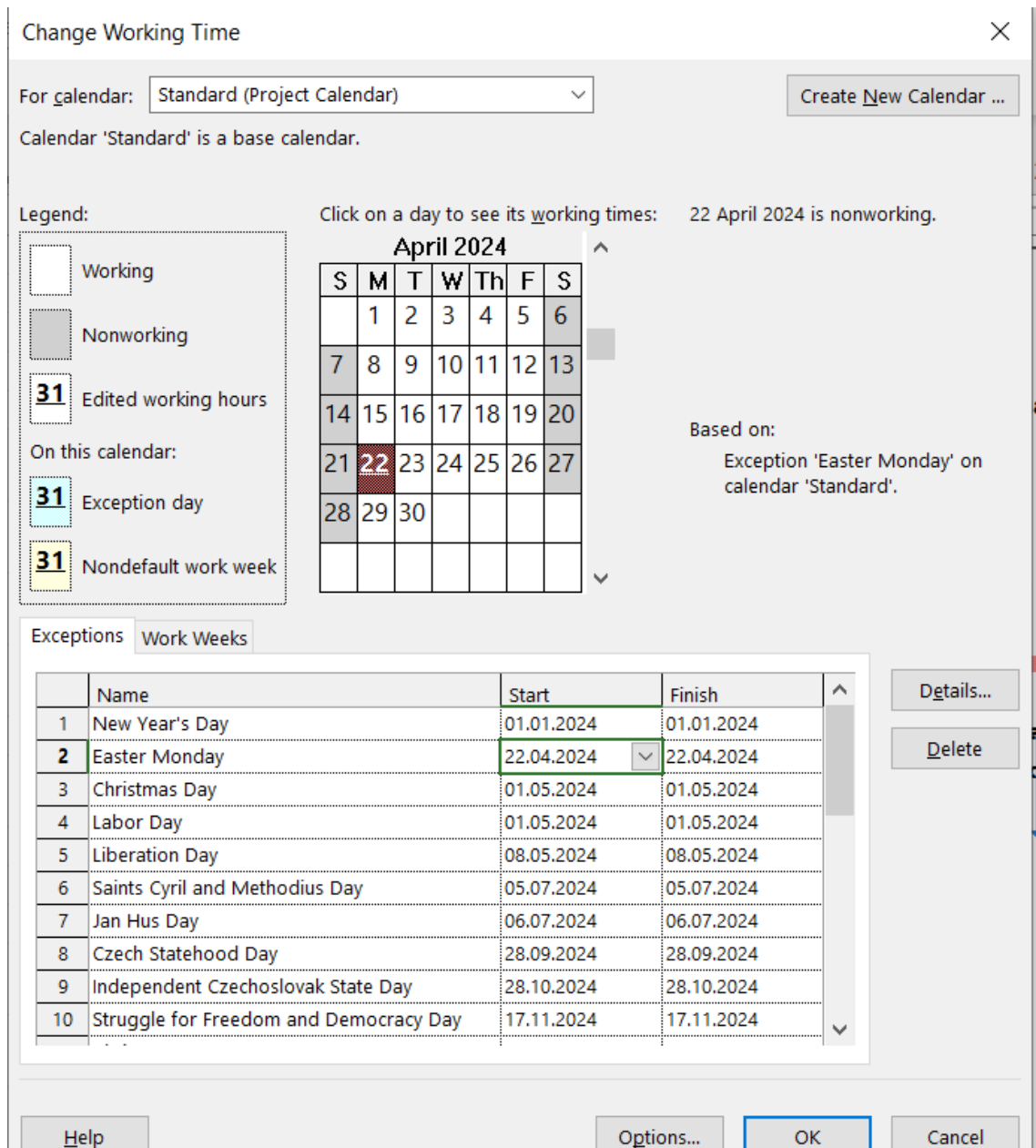


Figure 5.19: Configure holidays in the Czech Republic

Source: Own elaboration

The subsequent step involves inputting all the data from Table 5.7 into MS Project. By entering this information, we will generate a table that outlines the time frame for each individual task, phase, and the project as a whole. Additionally, this process will enable us to create a Gantt chart for visual representation and better understanding of the project timeline. A visual representation of Gantt Chart into the MS Project can be seen in Figures 5.20 and 5.21.

The provided diagrams reveal the key information we seek. The entire project is estimated to span 186 days, with the planning phase requiring 43 days, visual design taking 50 days, backend development consuming 79 days, frontend development lasting 67 days, and deployment needing 14 days. Additionally, the critical path can be identified within these diagrams. With this information at our disposal, we now have an idea of which tasks need to be completed in time for the project to be completed on time. The critical path is depicted in Figure 5.22.

The critical path, as observed, encompasses tasks ranging from planning to deployment, with the exception of frontend development. However, it predominantly focuses on backend development tasks. Key tasks within this area include planning the backend architecture, setting up the development environment, and integrating the database with the API.

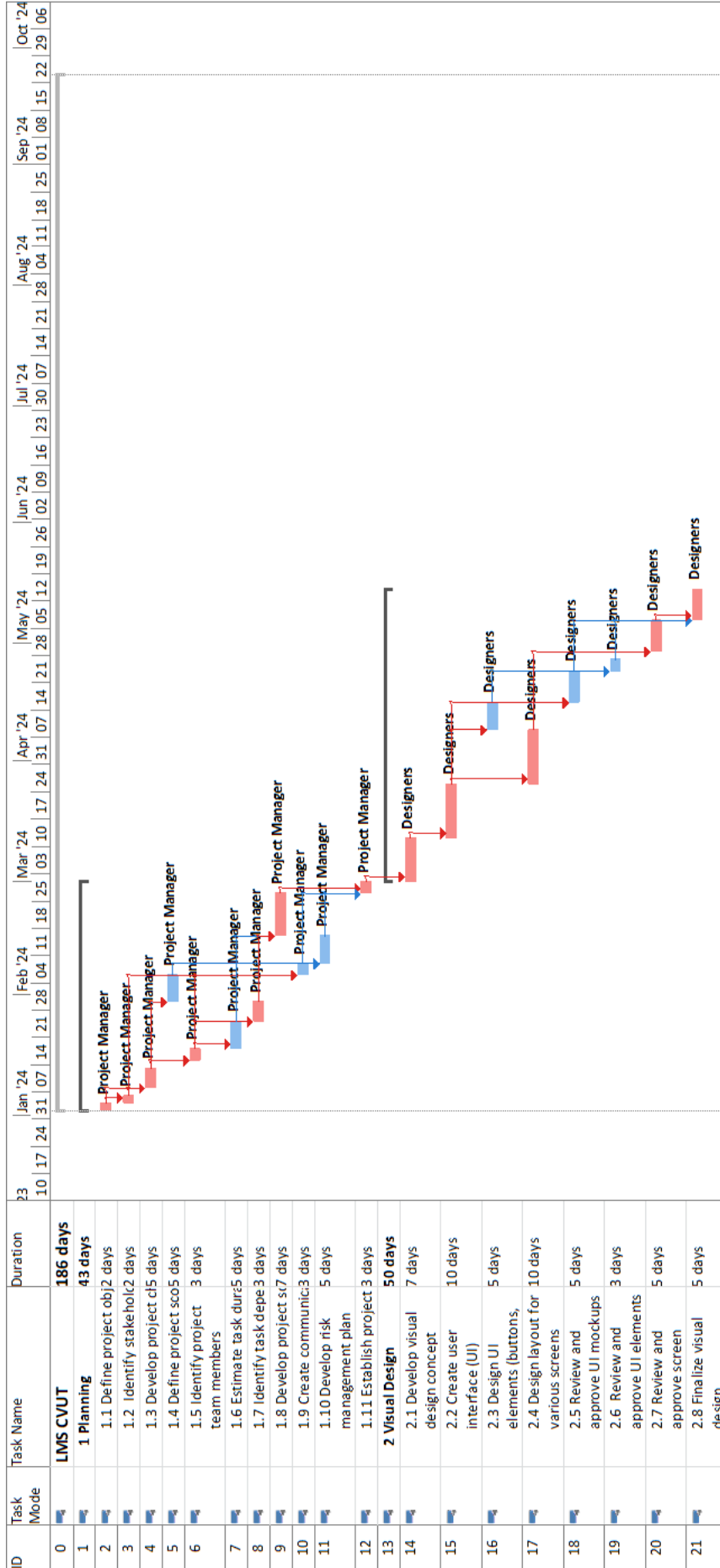


Figure 5.20: Gantt chart. Part 1  
Source: Own elaboration

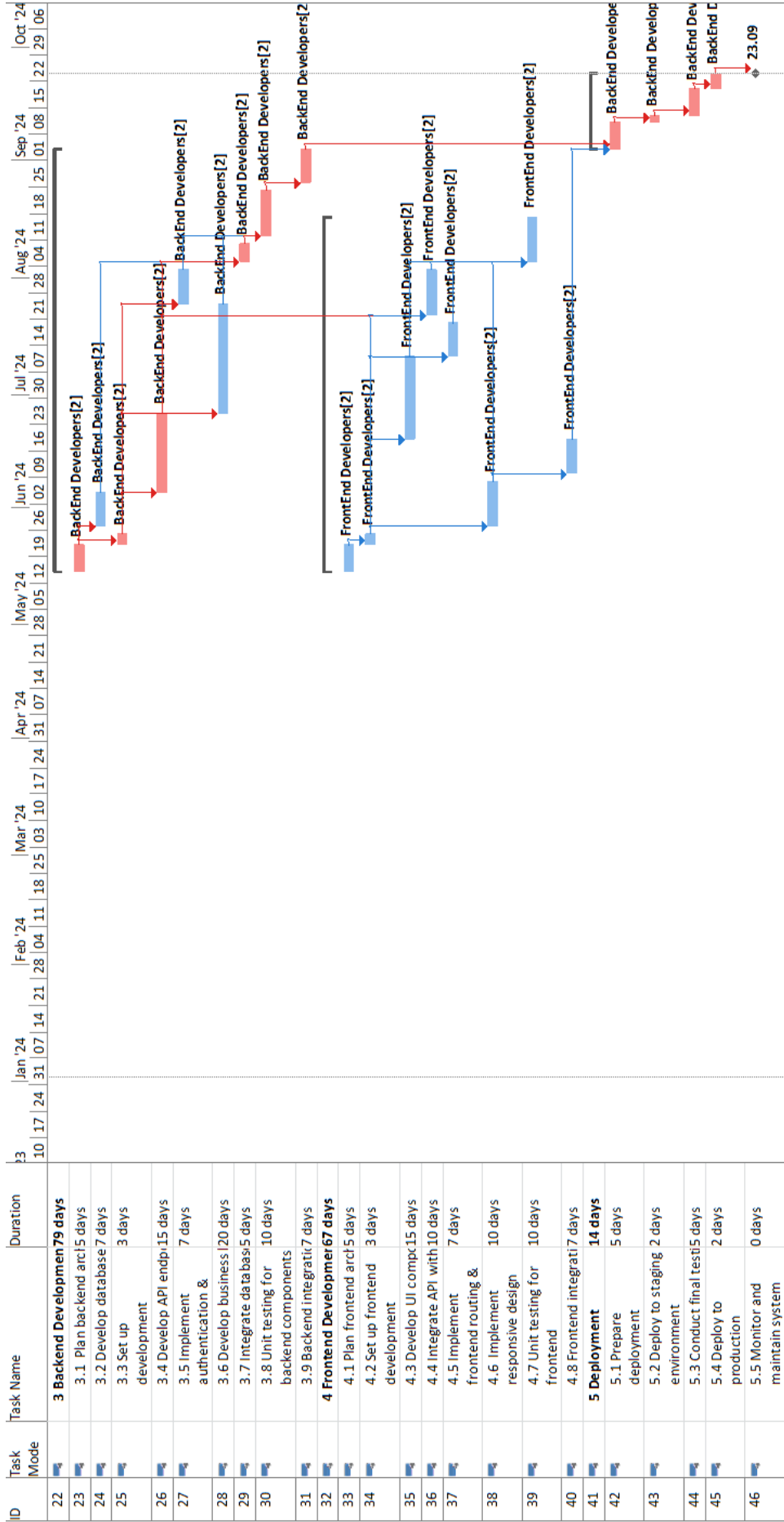


Figure 5.21: Gantt chart. Part 2  
Source: Own elaboration

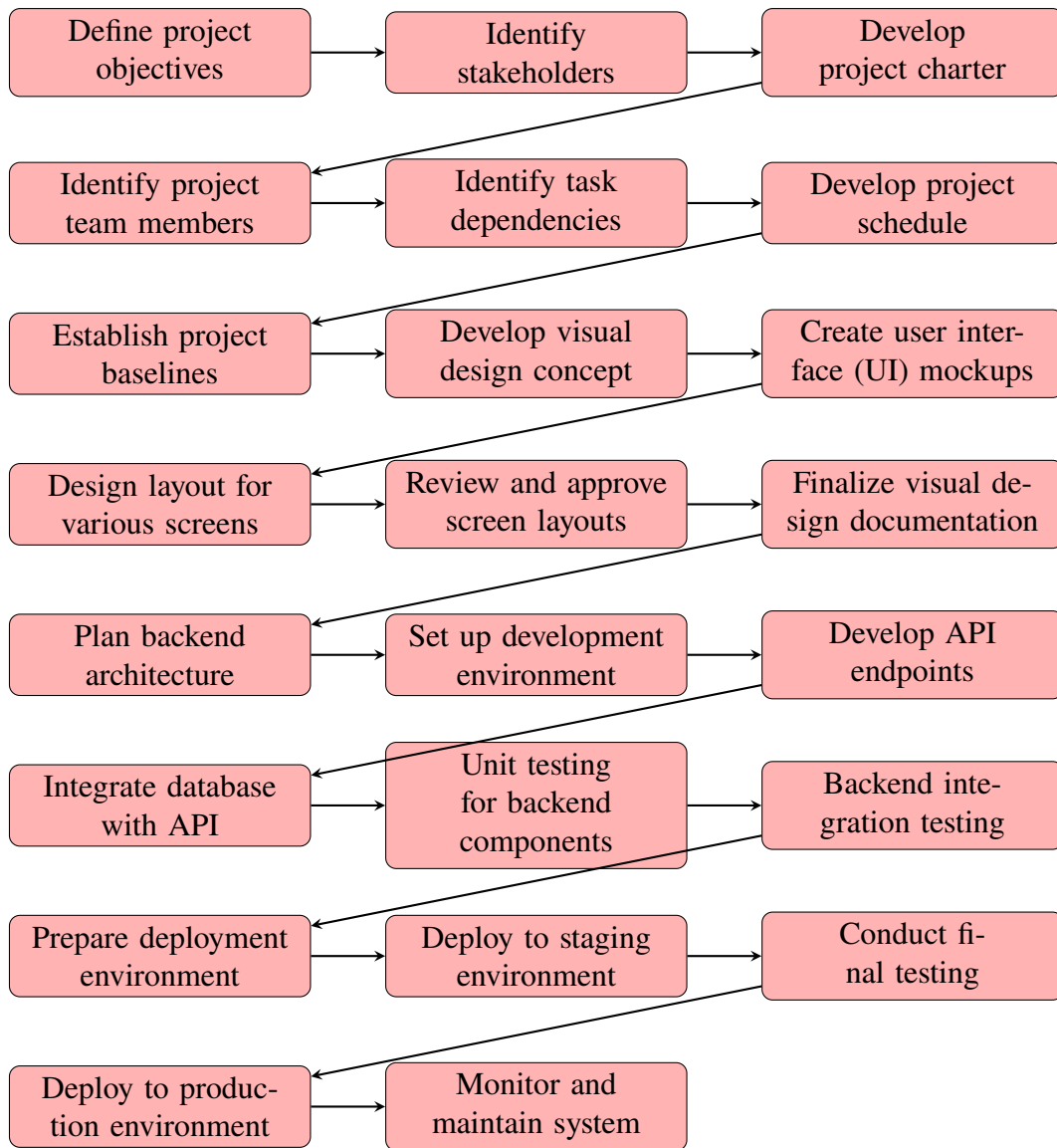


Figure 5.22: Critical path flowchart  
Source: Own elaboration

### 5.4.3 Estimating Project Costs

The final step in our analysis involves determining the cost of the project and its individual phases. MS Project offers a useful tool called Resources that enables us to assign team members, specify their hourly pay, and obtain financial results. First, we need to input the data from Table 5.5. A visual representation of this process can be seen in Figure 5.23.

	Resource Name	Type	Material	Initials	Group	Max.	Std. Rate	Ovt. Rate	Cost/Use	Accrue	Base
1	Designers	Work		DESGN	Design	1	\$30/hr	\$0/hr	\$0	Prorated	Standard
2	FrontEnd Developers	Work		FRONT	Eng	2	\$33/hr	\$0/hr	\$0	Prorated	Standard
3	BackEnd Developers	Work		BACK	Eng	2	\$38/hr	\$0/hr	\$0	Prorated	Standard
4	Project Manager	Work		MNGR	PM	1	\$32/hr	\$0/hr	\$0	Prorated	Standard

Figure 5.23: Resource sheet.

Source: Own elaboration

The subsequent step involves assigning each team member to their respective tasks. Once this is accomplished, by navigating to the "Cost" tab, we can obtain an overview of the estimated financial expenses for the project. The final cost breakdown is presented in Table 5.8.

Table 5.8: Costs of the project and its phases

Phase	Cost
Planning phase	\$11,008
Visual Design phase	\$12,000
Backend development phase	\$48,032
Frontend development phase	\$35,376
Deployment phase	\$8,512
<b>Total cost: \$114,928</b>	

Source: Own elaboration

An insightful perspective to consider is the distribution of costs among team members. A visual representation of the team cost allocation can be found in Figure 5.24.

## COST STATUS

Cost status for work resources.

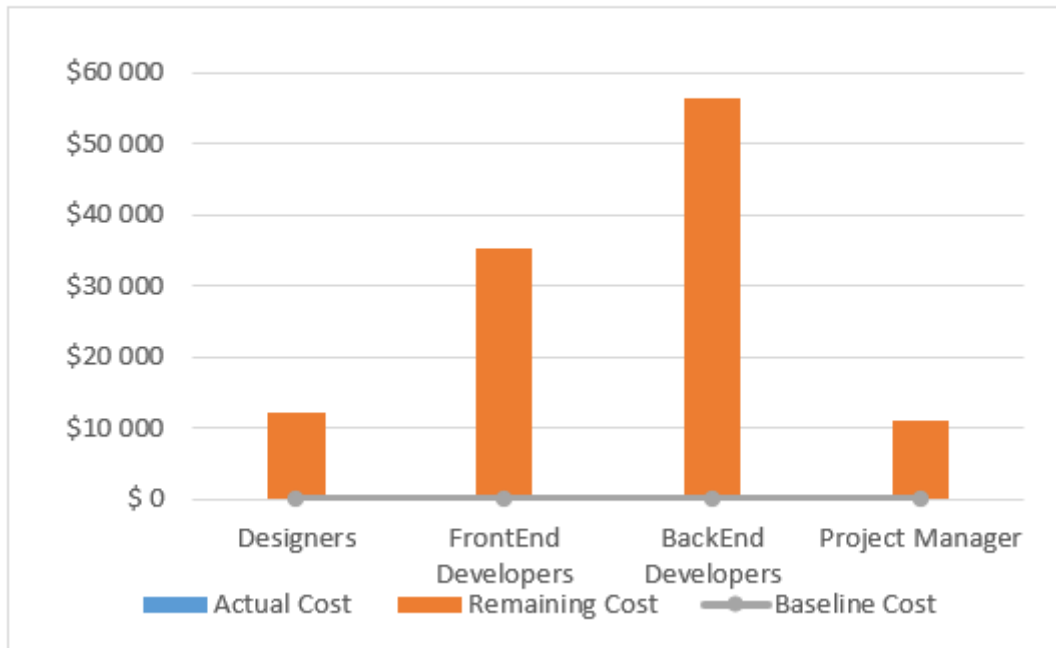


Figure 5.24: Resource cost overview.

Source: Own elaboration

Upon comparing Table 5.8 and Figure 5.24, it becomes apparent that the cost of the Backend Development phase does not precisely match the combined salaries of Backend Developers. This discrepancy occurs because the Backend Developers also played a significant role in the Deployment phase.



## 6. Conclusion

In recent years, the landscape of higher education has undergone significant changes due to increased economic pressures and heightened expectations from governments and societies. As a result, universities are diversifying their activities more than ever before. This has led to the emergence of various strategies for adapting and developing universities in this new context. In some countries, efforts are being made to create and implement different typologies for structuring the diverse network of higher education institutions, which in turn facilitate the creation of effective higher education development programs.

Educational programs shape the substance of education, which should encourage mutual understanding and collaboration among individuals and nations, irrespective of race, nationality, ethnicity, religious, or social background. It is important to consider a wide range of worldviews, support students' right to freely choose their opinions and beliefs, and ensure the personal development of each individual. This includes fostering the growth of their personality in accordance with family, community, spiritual, moral, social, and cultural values. Additionally, the content of vocational education and training should provide the necessary qualifications.

In recent times, higher education has been experiencing a multitude of significant transformations. The pressing task is to unify and modernize the structure of higher education, incorporating essential innovative components while preserving the solid classical foundation. Higher education aims to enhance the informational capacity of perceiving and processing professional information, providing students with a contemporary education that is attractive to potential employers, including those from abroad.

The advancement of modern distance education technologies at undergraduate, graduate, and postgraduate levels necessitates addressing the immediate challenges of preparing high-quality professionals for the future. This requires not only utilizing established and well-tested methods, such as offline and online lectures, webinars, coworking, and online testing, but also embracing more innovative and progressive approaches. These approaches should focus on developing not only essential professional competencies but also metacompetencies, such as intellectual-cognitive, design and research, reflexive, and creative thinking skills. These qualities can be actualized, shaped, and nurtured within a specially designed virtual-network educational environment of a contemporary university.

Analyzing the capabilities of learning systems, we can identify the main challenges in designing a distance learning system for students of higher education institutions:

- choosing a platform for creating the system;
- placement of training material;
- monitoring the learning process;
- resource administration;

- the possibility of expanding and modernizing the system.

To address these pressing issues and to further develop the distance learning system, this research work has been undertaken. The objective of this work was to develop a web application for organizing online education, which contributes to enhancing the quality of educational services in the university.

Considering the potential of modern technologies for teaching students, it can be concluded that the global Internet is the most suitable communication environment for organizing distance learning. In this case, the developed website effectively demonstrates the primary capabilities of distance learning applications. From a technical standpoint, the implementation of the system does not require significant economic resources and can be deployed based on the CTU site. The object-oriented approach employed in the development process allows for further system modernization.

It should be noted that the created learning management system represents the initial stage of integrating modern technologies into learning processes. In subsequent work, it is necessary to consider the specific requirements of the higher education institution. In particular, the introduction of video communication technologies could be the next step in the development of the distance learning system.

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## References

### List of Literature Used

1. Bernhard, Andrea (2018). *Quality assurance in higher education: an introduction*.
2. Box, Don et al. (2000). *Simple Object Access Protocol (SOAP) 1.1*. W3C Note, 8(10).
3. Fielding, Roy T and Richard N Taylor (2002). “Principled design of the modern Web architecture”. In: *ACM Transactions on Internet Technology (TOIT)* 2.2, pp. 115–150.
4. Fielding, Roy Thomas (2000). “Architectural Styles and the Design of Network-based Software Architectures”. PhD thesis. University of California, Irvine.
5. Flanagan, David (2011). *JavaScript: The Definitive Guide*. O’Reilly Media.
6. Frain, Ben (2012). *Responsive Web Design with HTML5 and CSS3*. Packt Publishing.
7. Fredman, Pam (2023). “Higher education based on cooperation and interdisciplinarity has a key role in a global sustainable development”. In: *On the horizon*.
8. Gillies, James and Robert Cailliau (2000). *How the Web was Born: The Story of the World Wide Web*. Oxford University Press.
9. Hardt, Dick (2012). *The OAuth 2.0 authorization framework*. RFC 6749, The Internet Engineering Task Force (IETF).
10. Jones, Michael, John Bradley, and Nat Sakimura (2015). *JSON Web Token (JWT)*. RFC 7519, The Internet Engineering Task Force (IETF).
11. Kurose, James F. and Keith W. Ross (2017). *Computer Networking: A Top-Down Approach*. 7th. Pearson.
12. Marcotte, Ethan (2011). *Responsive Web Design*. A Book Apart.
13. O’Reilly, Tim (2007). “What is Web 2.0: Design Patterns and Business Models for the Next Generation of Software”. In: *Communications & Strategies* 65, pp. 17–37.
14. Pautasso, Cesare, Olaf Zimmermann, and Frank Leymann (2008). “RESTful web services vs. “big” web services: making the right architectural decision”. In: *Proceedings of the 17th international conference on World Wide Web*, pp. 805–814.
15. Rescorla, Eric (2018a). “The Transport Layer Security (TLS) Protocol Version 1.3”. In.
16. – (2018b). *The Transport Layer Security (TLS) Protocol Version 1.3*. RFC 8446.
17. Richardson, Chris and Floyd Smith (2018). *Microservices patterns: With examples in Java*. Manning Publications Co.
18. Russell, Alex and Richard Berriman (2019). *Progressive Web Apps*. Manning Publications.
19. Souders, Steve (2007). *High Performance Web Sites: Essential Knowledge for Front-End Engineers*. O’Reilly Media.

## Internet resources

1. Authors, The Go (2023). *Golang*. URL: <https://golang.org/>.
2. Berners-Lee, Tim (2010). “Long Live the Web: A Call for Continued Open Standards and Neutrality”. In: *Scientific American* 303.6, pp. 80–85. URL: <https://www.scientificamerican.com/article/long-live-the-web/>.
3. Blueprint, API (2021). *API Blueprint: A powerful high-level API design language for web APIs*. URL: <https://apiblueprint.org/>.
4. Express (2023). *Express Web Framework*. URL: <https://expressjs.com/>.
5. Foundation, GraphQL (2021). *GraphQL: A query language for your API*. URL: <https://graphql.org/>.
6. Foundation, Node.js (2023). *Node.js*. URL: <https://nodejs.org/>.
7. Foundation, Python Software (2023). *Python*. URL: <https://www.python.org/>.
8. Group, The PHP (2023). *PHP*. URL: <https://www.php.net/>.
9. Inc., Facebook (2021). *React – A JavaScript library for building user interfaces*. URL: <https://reactjs.org/>.
10. Inc., Google (2021). *Angular: One framework. Mobile desktop*. URL: <https://angular.io/>.
11. Language, Ruby Programming (2023). *Ruby*. URL: <https://www.ruby-lang.org/>.
12. Laravel (2023). *Laravel Web Framework*. URL: <https://laravel.com/>.
13. MongoDB (2023). *MongoDB NoSQL Database*. URL: <https://www.mongodb.com/>.
14. MySQL (2023). *MySQL Database*. URL: <https://www.mysql.com/>.
15. *OWASP Dependency-Check* (2021). <https://owasp.org/www-project-dependency-check/>.
16. *OWASP Top Ten Project* (2021). <https://owasp.org/www-project-top-ten/>.
17. Paoli, Jean, Eve Maler, and C. M. Sperberg-McQueen (2017). *HTML 5.2*. World Wide Web Consortium. URL: <https://www.w3.org/TR/html52/>.
18. Project, Django (2023). *Django Web Framework*. URL: <https://www.djangoproject.com/>.
19. Rails, Ruby on (2023). *Ruby on Rails Web Framework*. URL: <https://rubyonrails.org/>.
20. Statista (2021). “Market size of the global corporate e-learning industry in 2019 with a forecast for 2026”. In: *Statista*. URL: <https://www.statista.com/statistics/1232427/global-corporate-e-learning-market-size/> (visited on 04/07/2023).
21. Swagger (2021). *Swagger: API Development for Everyone*. URL: <https://swagger.io/>.

