ALLIES

Digital Training Tools in Steel Structure Integrity

Transnational plan for deployment the postgraduate programme study in HE community

Project coordinator:

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1. Introduction

The COVID-19 pandemic has brought to light severe gaps and shortcomings in digital skills, connectivity, and educational technology utilisation. Furthermore, according to the most recent Index of the Digital Economy and Society, 42% of Europeans lack fundamental digital skills, and the European labour market is experiencing a substantial shortage of digital expertise. Beginning in March 2020, the "COVID-19" crisis has shifted educational methods away from "face-to-face" engagement into an online environment. This difficulty underlined the importance of digital education as a vital goal for high-quality, accessible, and inclusive teaching-learning assessment and the need for a planned approach to obtaining digital skills throughout life for all actors involved. ALLIES focuses on two target groups: university teachers and professionals (mechanical, civil, and industrial engineers). Furthermore, ALLIES aims to improve digital education in engineering sciences by focusing on two types of specialisations: ITC and steel structure integrity [1].

Teaching-learning activities have primarily moved to the online environment, and the challenges that education systems have faced have been related to (a) insufficiently developed digital skills for the efficient organisation of the teaching process in the online environment, (b) insufficient skills in the production of digital materials, particularly in the field of engineering sciences, and (c) the outcomes of the above. The necessity for a planned approach to developing digital skills throughout one's life is now more critical than ever.

Given the influence of digital transformation on societies, the labour market and its future, and education and training systems, the Digital Education Action Plan calls for stronger cooperation across EU Member States to ensure that education and training systems fit the digital age. According to this viewpoint, advancements in connection, widespread use of digital devices and applications, the need for individual flexibility, and the growing demand for digital skills are driving the digital transformation in education. At the same time, it is a call for action for closer cooperation at the European level to conclude the crisis caused by the COVID-19 pandemic, during which technology is used at the highest level in the field of education and training, respectively for adapting education and training systems to the digital age.

In the steel structure construction sector, the development of new digital tools has led to the identification of a lack of skills of engineering professionals in the use of digital tools for the design, analysis and inspection of metal structures. In 2021, only 54 % of EU citizens had fundamental digital abilities, according to DESI (Digital Economy and Society Index) which is aimed to be increased up to 80 % until 2030 [2].

2. Aims

The training is divided into two 28-hour-workload units: Unit 1: Steel Structure Integrity Inspection and Unit 2: Computer and Simulation in Steel Structure Integrity Design, to improve the quality and accessibility of online civil engineering postgraduate courses represented by digital educational tools. Developing a strategy to train and assist teachers in postgraduate programs in using the created digital educational toolbox would enhance their competency in using and introducing digital educational resources. Furthermore, teachers who have learned to use digital toolboxes can apply their new skills in any online course higher education institutions offer. The primary purpose of this transnational action plan is to provide opportunities for international learning and teacher exchange among ALLIES partners and outside the consortium.

2.1. Learning Outcomes of the programme

The European Qualifications Framework (EQF) is a common reference framework that assists the education and training entities, employers and individuals throughout Europe in comparing qualifications in the various education and training systems, hence enabling trainee and worker mobility in the EU. Thus, implementing EQF enhances worker and trainee mobility and contributes to recognising their qualifications outside of their home countries.

The EQF tool is based on learning outcomes, which have the following key reference level descriptors:

a) Knowledge,
b) Skills, and
c) Autonomy and Responsibility (Attitudes).

To match the new ALLIES competence units with EQF, the consortium wrote its learning outcomes from the perspective of learners (using a new learning outcomes approach that focuses on establishing specific and visible learning results).

2.1.1. Competence units

Competence unit 1 details the topic of steel structure integrity inspection, from which the postgraduate students will obtain a comprehensive and specialised knowledge of (a) Risk Based Inspection (RBI), (b) Non-Destructive Testing (NDT), and (c) Standards, rules and specifications on steel structures integrity. At the end of competence unit 1, the students are expected to be able to:

a) Identify and interpret guidelines, standards and applicable law related to the infrastructure assigned;
b) Assess requirements and constraints on the use of the RBI when the infrastructures are assigned and the resources available;

c) Evaluate the level of risk of a steel structure according to a given reference;
d) Verify the most effective NDT according the materials and types of structures;
e) Design a preliminary plan for maintenance inspection.

Competence unit 2 details the topic of computer and simulation in steel structure integrity design, from which the postgraduate students will obtain a comprehensive and specialised knowledge of (a) steel structure designing, (b) basic modelling and simulation, and (c) acknowledgement of the main types of damage mechanisms. At the end of competence unit 2, the students are expected to be able to:

a) Read and interpret technical drawings of structures;
b) Interpret and understands the results of the finite elements analysis;
c) Use specific designing software to design steel structures;
d) Simulate steel structure integrity through digital tools;
e) Use digital tools to model steel structures;
f) Identify potential design issues after performing the steel structure integrity simulation;
g) Identify the main damage mechanism acting in the inspected structure;
h) Evaluate the integrity risks and define mitigating actions.

2.1.2. Disciplines

The postgraduate students will obtain the abovementioned knowledge and skills by learning the following subjects. The Unit of Steel Structure Integrity Inspection includes four subjects, while the Unit of Computer and Simulation in Steel Structure Integrity Design includes three subjects, listed in Table 1. Both units correspond to 1 ECT in the European Credit System.

Table 1. Subjects of the training course based on PR3 and PR4

Competence Unit 1 **STEEL STRUCTURE INTEGRITY INSPECTION**	**CONTACT HOURS**	**WORKLOAD**
SUBJECT TITLE		
Introduction to Risk Based Inspection	2	4
Non-Destructive Testing	4	8
Standards, Rules and Specifications	2	4
Case Studies	4	12
Total	**14**	**28**
ECT	**1**	
Competence Unit 2 **COMPUTER AND SIMULATION IN STEEL STRUCTURE INTEGRITY DESIGN**	**CONTACT HOURS**	**WORKLOAD**
SUBJECT TITLE		
Introduction to Design of Steel Structures	4	8
Introduction to Modelling and Simulation	4	8
Main Types of Damage Mechanisms	4	12
Total	**12**	**28**
ECT	**1**	

3. Methodology for implementation

As most teachers are not officially trained in the use of digital education tools, the ALLIES project includes a training material for teachers in postgraduate programmes to use the developed digital education toolbox.

3.1. Pedagogical strategies

Teaching in an online postgraduate civil engineering program with a digital toolbox requires careful planning and effective pedagogical strategies that leverage the advantages of technology while promoting effective learning outcomes. In this guideline, we provide recommendations for higher education teachers to enhance their teaching practices and optimise student learning outcomes in an online setting.

The curriculum that has been designed in PR4 includes the clearly defined learning outcomes of the competence units, also listed in chapter 2.1.1. of this document. The programme builds on the knowledge of postgraduate students and includes industry-relevant case studies.

The provided educational materials for the subjects are helpful for students to learn from and the teachers to create presentations, videos, questionnaires, and tasks for the students. In the following, some strategies for digital training are detailed.

Utilising interactive multimedia elements such as videos, simulations, animations, games, and virtual reality to provide visual and interactive representations engages students and enhances their comprehension through immersive experiences. It was found that students who used interactive e-learning technologies, such as simulations and games, were more engaged and performed better than students who used passive e-learning technologies, such as online lectures and readings [3]. Essentially, online lectures are needed in a postgraduate training, but the lectures should include the abovementioned elements. The use of artificial intelligence in teaching will be more and more widespread in the upcoming years [4]. For example, videos and presentations can already be created from the developed educational materials with less effort than ever with the help of artificial intelligence.

Students are generally more successful when they can learn at their own pace. This can be done by using asynchronous learning tools and resources. Asynchronous learning is a type of learning that does not require students and teachers to be online at the same time. This makes it ideal for postgraduate students who are working full-time or who have other commitments. With recorded online lectures students can watch at their own pace and rewind or fast-forward as needed.

It is beneficial to incorporate collaborative learning experiences through online platforms or tools. This can be done through online discussion forums, group projects, and peer review. Collaboration helps students to learn from each other and to develop

their critical thinking skills. Foster an environment that encourages students to learn from each other, share insights, and engage in problem-solving activities together. The success of group projects is depending on various factors. For example, the students should have a clear understanding of the project goals and objectives. The groups should be small enough to allow for meaningful involvements from all members, but large enough to provide diverse perspectives and skills [5]. Furthermore, establishing regular communication channels, such as video conferences, discussion boards, and email, encourage student-faculty interaction. This fosters a sense of community, addresses concerns, and allows students to seek clarification on course content or assignments.

The developed postgraduate civil engineering program includes a subject on case studies, as active learning strategies are found to encourage student reflection and critical thinking. Case studies provide students with opportunities to apply what they have learned in the classroom to real-world problems. This can help students develop their problem-solving skills, ability to think critically, and understanding of the complex challenges that civil engineers face. In addition, case studies can help students to develop their communication and collaboration skills. When working on case studies, students often need to work together to research the problem, develop solutions, and present their findings. This can help students to learn how to work effectively as part of a team and how to communicate their ideas clearly and concisely [6].

Continuous assessment and feedback are essential for helping students to learn and improve their performance. Feedback can be provided through online quizzes, assignments, and discussion forums. A study found that the type of immediate feedback used can make a difference. Immediate feedback that is specific, constructive, and timely feedback is more likely to positively impact student learning [7]. The use of partial credit iterative responding increase the overall score of students [8]. Another study found that online quizzes can also positively impact on student success, especially when they are well-designed, aligned with the course material, and used in conjunction with other teaching and learning strategies. Line quizzes also improve student learning outcomes [9].

By implementing these pedagogical strategies, a digital postgraduate civil, mechanical, materials, and manufacturing engineering program can provide an engaging and effective learning experience for students, preparing them for successful careers in the field.

3.2. Benefits of digital education tools

In recent years, the landscape of education has undergone a radical transformation, propelled by the rapid advancement of digital technologies. The integration of digital tools has ushered in a new era of learning, one that is dynamic, interactive, and tailored to the needs of diverse learners. This chapter aims to delve into the multitude of benefits

offered by digital educational tools, elucidating how they have become indispensable assets in the modern educational sphere.

One of the primary advantages of digital educational tools lies in their ability to bridge geographical and socioeconomic gaps. By leveraging these tools, educators can reach students in remote areas and underserved communities, granting them access to high-quality educational resources that were previously out of their reach. Additionally, these tools cater to diverse learning styles, ensuring that students with varying abilities and needs can engage with the material at their own pace and in ways that suit their individual preferences [10].

Digital educational tools have revolutionised the concept of personalised learning, enabling educators to create customised learning paths that cater to each student's unique requirements. Through data analytics and adaptive learning algorithms, these tools can track students' progress, identify their strengths and weaknesses, and provide targeted interventions to bolster their understanding. This adaptability fosters a supportive learning environment that nurtures individual growth and maximises the potential for academic success. Amhag et al [11] found that teacher educators use information- and communication-based teaching (ICT) in four different ways: for teaching, communication, administration, and research. Furthermore, mobile digital tools can support a variety of teaching methods in different contexts. However, teacher educators need more training in ICT and how to use it effectively in teaching situations.

Digital educational tools inject an element of interactivity and engagement into the learning process, captivating students' attention and fostering a deeper understanding of complex concepts. Through multimedia elements, virtual simulations, and gamified learning modules, students can actively participate in their learning journey, making education a stimulating and enjoyable experience rather than a tedious chore. Körei et al. [12] have found that to effectively teach Generation Z students, educators should emphasise small group learning and incorporate games and game-based elements into the curriculum. This approach caters to their preference for active engagement and hands-on learning. While traditional frontal teaching may still have a place, it should be complemented by collaborative learning techniques that allow students to interact with peers and apply their knowledge in practical settings. Additionally, educators should tailor their teaching methods to the specific subject matter, recognising that different subjects may require different approaches to maximise student engagement and learning outcomes.

Anastasiadis et al. [13] found that digital game-based learning is an effective educational tool that can enhance students' learning experience and promote active interaction and communication. It offers several benefits, including increased motivation and engagement, improved cognitive growth and digital literacy, enhanced decision-making and problem-solving skills, as well as critical thinking. It can also be combined with other

learning methodologies to further enhance students' learning experience. Education should not only focus on teaching fundamental knowledge but also on preparing students for their life ahead. Digital game-based learning can be utilised as an educational tool to boost students' wellbeing and self-esteem, help them improve their soft skills, develop their critical thinking, decision-making and problem-solving skills, as well as maintain a healthy mental and psychological balance.

Al Rawashdeh et al [14] concluded that e-learning is an effective tool for transferring knowledge and has the potential to replace traditional teaching methods. E-learning training is beneficial for both learners and instructors. Students' needs are becoming a priority for instructors, and as a result, universities and colleges are incorporating e-learning systems into their own training programs. Some advances were stated as e-learning enhances communication between teachers and students, it develops students' skills and provides scientific material in an interesting manner. Overall, e-learning is a valuable tool for education, but it is important to address the potential drawbacks and ensure that students have the support they need to succeed.

Henderson et al [15] on the other hand found that digital technologies have become a central element of undergraduate education, but they are not fundamentally transforming the nature of university teaching and learning. Universities should continue to support the logistical and study-focused uses of digital technologies that are currently popular among students. If they want to see students use digital technologies in more expansive, expressive, and empowering ways, they need to create contexts where these alternative uses will be valued and supported.

Lohr et al [16] found three levels of teacher-initiated digital learning activities in higher education courses: low (powerpointers), moderate (clickerers), and high (digital pros). The study also found that the digitalisation policy, institutional equipment, and teacher training, were related to the level of teacher-initiated digital learning activities. This suggests that universities can help teachers to use a broader range of digital learning activities by providing support for these contextual factors. A comprehensive approach to organisational development that addresses digitalisation strategy, teacher qualification, and equipment is more likely to be successful than isolated measures.

In conclusion, the benefits of digital educational tools are multifaceted, ranging from enhanced accessibility and inclusivity to personalised learning, interactive experiences, global connectivity, and sustainable resource management. As the educational landscape continues to evolve, it is imperative for educators and policymakers to harness the full potential of these tools, leveraging them to create an inclusive, engaging, and sustainable learning environment that prepares students for the challenges of the 21st century.

3.3. Learning Management Systems (LMS)

The developed digital toolbox is an innovative tool for online postgraduate civil engineering courses, which have gained significant interest in recent years.

In recent years, the education sector has witnessed a massive transformation due to the rapid advancements in technology. Traditional methods of teaching and learning are being phased out, making way for more digital and flexible approaches. A key component of this digital revolution is the Learning Management System (LMS), a software application that has revolutionised the way educational institutions deliver content and interact with learners [14].

A Learning Management System, often referred to as an LMS, is a digital platform that centralises and streamlines the administration, delivery, and tracking of educational content. It provides a powerful set of tools for planning, delivering, and managing educational courses, whether they are online or conducted in a physical classroom. LMS platforms are highly versatile and can be customised to meet the unique needs of various organisations, including schools, universities, corporations, and non-profit organisations. An LMS allows instructors to create engaging online courses by incorporating multimedia elements, such as videos, quizzes, and interactive activities. It enables learners to access course materials from anywhere at any time, facilitating flexibility and personalised learning. LMS platforms offer a range of administrative features, allowing instructors to set deadlines, create course schedules, manage enrolment, and automate various administrative tasks. This streamlines the overall management of courses and reduces the administrative burden on teachers. LMS platforms promote collaboration and communication among learners and instructors. Discussion boards, chat rooms, and video conferencing tools enable learners to connect with their peers and instructors, fostering meaningful interactions and knowledge sharing. LMS platforms provide extensive tracking and assessment capabilities. Instructors can monitor learners' progress, track their engagement with course materials, and evaluate their performance through quizzes, assignments, and exams. This data-driven approach facilitates informed decision-making and helps identify areas for improvement [17].

Coates et al [18] conducted a study in 2005, with the results stating that the future of learning management systems (LMS) in higher education should be the subject of broad and inclusive discussion. Decisions about the adoption, implementation, use, and review of LMS should involve a wide range of stakeholders, including academic staff, students, and administrators. Institutions should also invest in educating staff about online pedagogy and providing support for those who use LMS. Finally, institutions should conduct ongoing evaluations of the educational and organisational effects of LMS.

Watson [19] had similar thoughts, as LMSs are a powerful technology with the potential to revolutionise education. However, there is a lack of research on how to effectively implement and use LMSs. More research is needed to identify the features of LMSs that are most effective for learning, as well as the needs of learners, teachers, parents, and other stakeholders.

de Oliveira et al [20] used an integrative review method to map the studies in the Web of Science, Scopus, Ebsco and Scielo databases, regarding the use of LMS in the e-learning management. The analysis focused on categories that can characterise the scientific production about the LMS use in the e-learning management, with the following findings: (a) there is a growing academic interest from different countries to develop research related to LMS use in e-learning management, (b) the most common LMS used in e-learning management is Moodle, (c) the most common categories analysed in the studies were Coordination, Administrative Support, and Didactic Resources, (d) most of the studies approach the administrative functions of LMS on a non-integrated manner and focusing educational information, (e) there is a lack of clear theoretical definitions on the relationship between the LMS and the e-learning management, and (f) there is a need for more empirical research on the topic. They recommended that future research should focus on the following questions: (a) How does LMS influence e-learning planning, direction, execution, and control from the manager perspective? (b) What does the e-learning manager need in relation to the technological platform used? and (c) Is there an effective alignment between IT and the e-learning processes?

Both Cavus [21] and Al-Ajlan [17] found that there are a growing number of LMS options, and it is becoming increasingly difficult to choose the best one. Both studies found that Moodle is the most popular LMS among open-source options, with a large user base and user-friendly interface. Other LMS options, such as Claroline and Sakai, have more complex interfaces and may be more difficult to use. Researchers recommend using a software program like EW-LMS to help evaluate and choose the best LMS for your needs.

In conclusion, Learning Management Systems have undoubtedly revolutionised the education industry by providing a flexible and efficient solution for course delivery, administration, and assessment. Their extensive features and benefits empower instructors to create engaging and personalised learning experiences while enabling learners to access educational materials anytime, anywhere. As educational institutions continue to embrace digital transformation, LMS platforms will become indispensable tools for educators, contributing to the ongoing evolution of the teaching and learning landscape.

3.4. Use of the ALLIES digital education toolbox (how-to)

The outputs of the ALLIES project can be reached at the project website through the following URL: https://www.alliesproject.eu/results.html. These documents help the teachers and trainers find the proper tools to apply the abovementioned pedagogical strategies in teaching the course units.

The course materials in English have been uploaded to the LMS platform Canvas. Based on the following how-to, the other harmonised and translated (Romanian, Italian, Portuguese, Spanish and Hungarian) course materials can also be used in the digital training of the developed steel structure integrity programme.

The enrolment to the course and the overview of the ALLIES course are detailed below. Figure 1 shows the enrollment screen, whether the person is a new user or registered in Canvas.

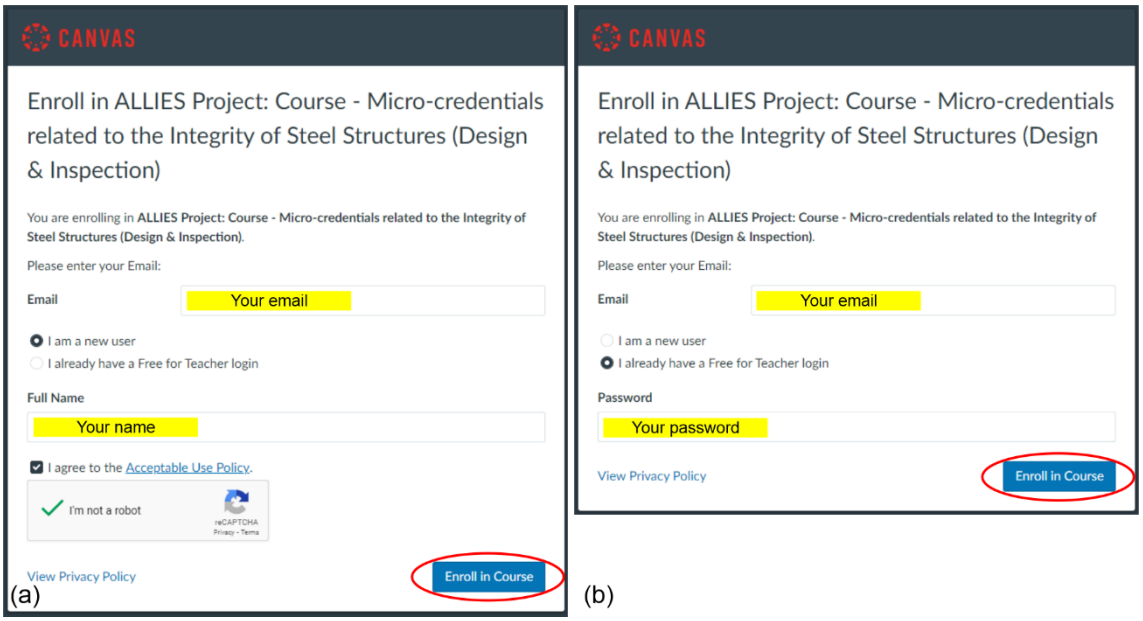

Figure 1. Enroll on the ALLIES course as a new user (a), enroll as a registered Canvas user (b)

After successfully enrolling in the ALLIES course, it will appear on the Dashboard (Figure 2) from the left menu bar.

When opening the course, the Home page appears, with the ALLIES introduction, all the subject units of the two competence modules, and the questionnaire for each unit (Figure 3). Every document and questionnaire can be reached in English by clicking on the titles from this page.

The questionnaires can also be accessed from the Assignments tab, the Quizzes tab, and the Grades tab. On the latter, the scores of the students in each topic can be monitored (Figure 4). The units are also available from the Pages tab.

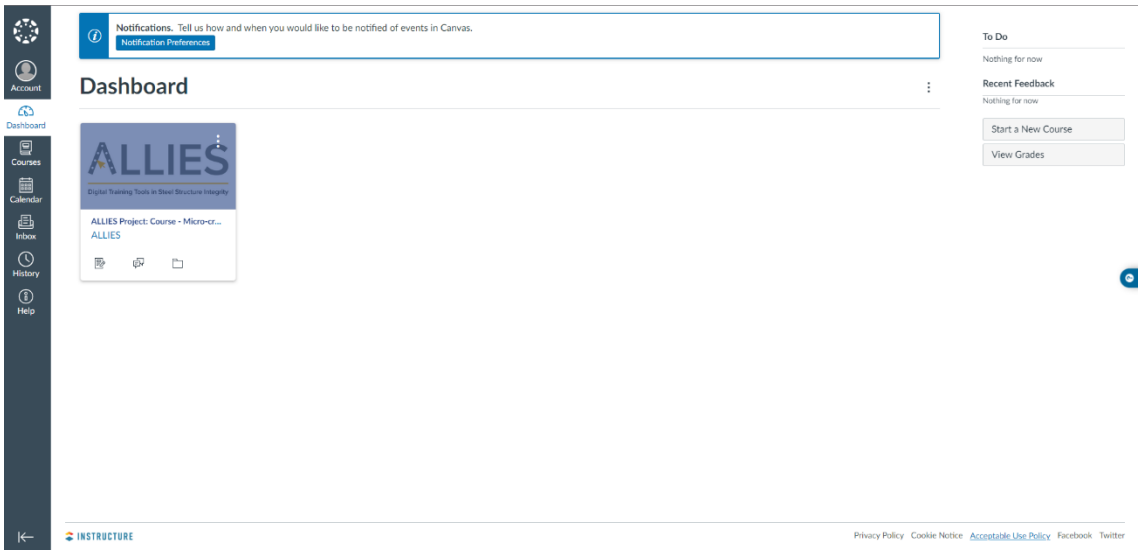

Figure 2. Canvas Dashboard with the ALLIES course

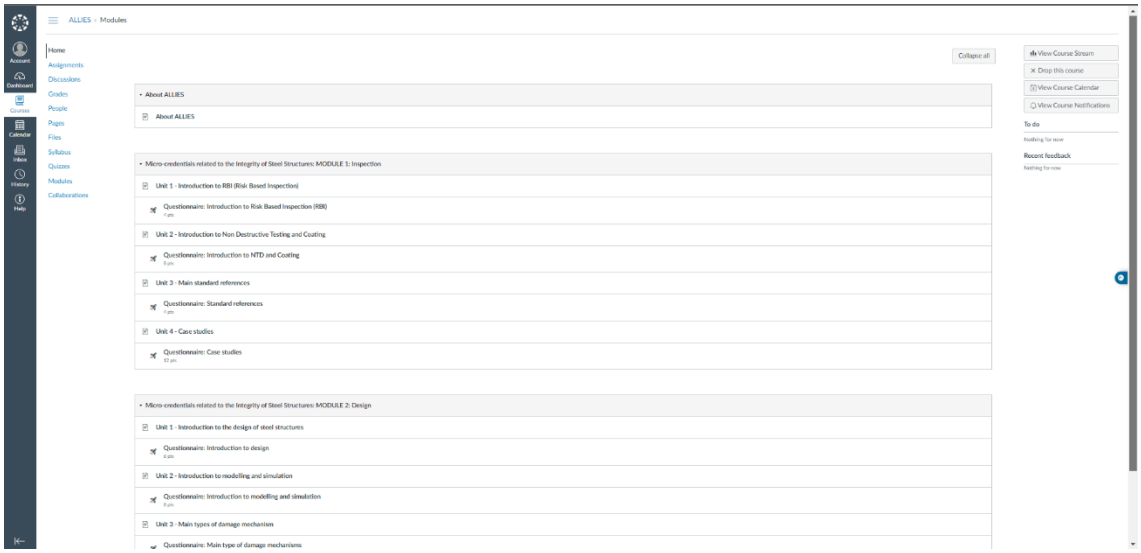

Figure 3. Home page of the ALLIES course in Canvas

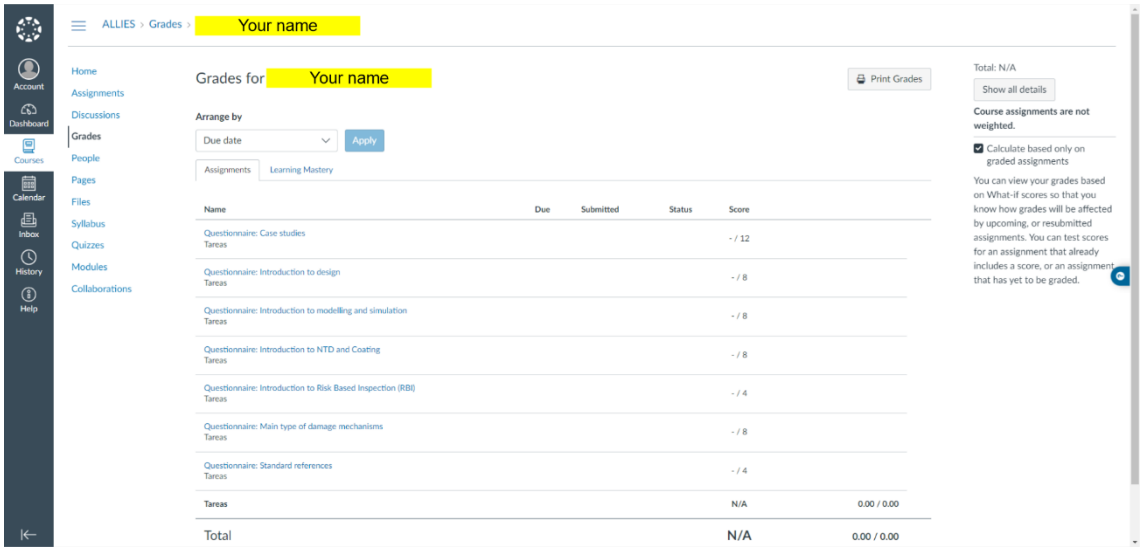

Figure 4. Scores of the questionnaires for one selected student

The platform also allows to see other enrolled people (teachers and students) on the People tab. If they add contact details, biographies, or links, they will be visible on their profile. The own Canvas profile of the user can be reached from the left menu bar, under the Account page (Figure 5).

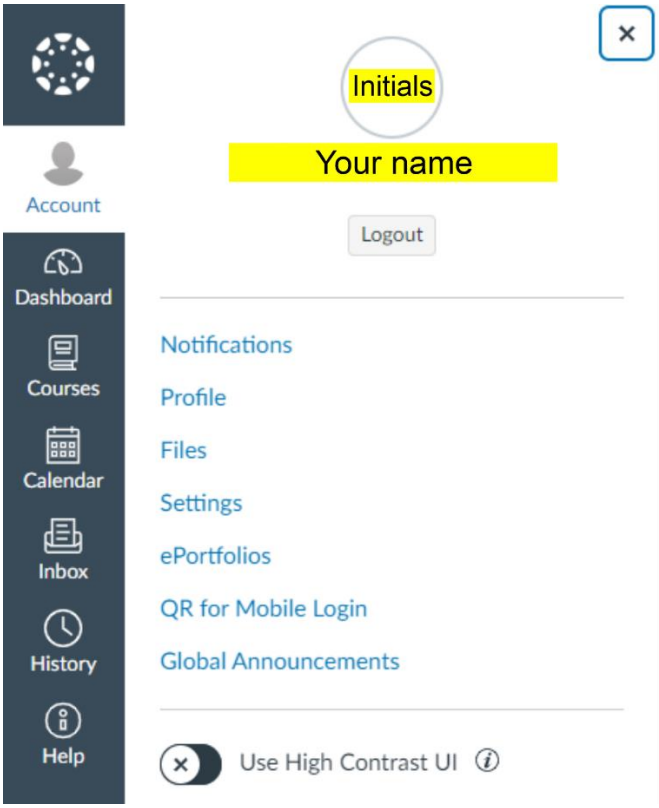

Figure 5. Own account page

Finally, to benefit from the features of the LMS platform, the Discussions tab (Figure 6) allows users to communicate with each other by creating threads and commenting on them. Another feature is that shared Google documents can be imported into the Canvas system under the Collaborations tab to take shared notes, for example.

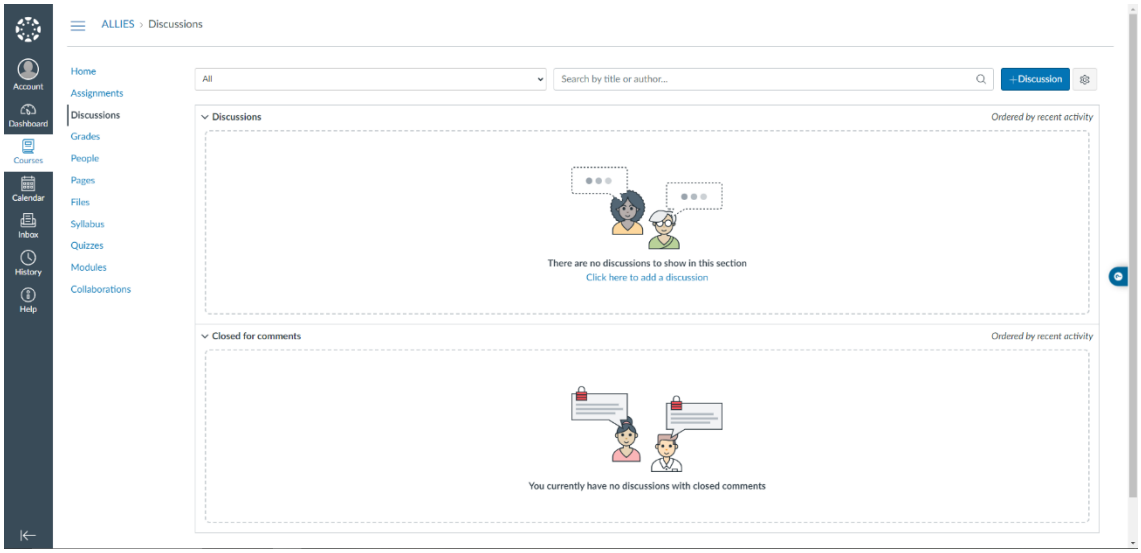

Figure 6. Discussions page with the opportunity to communicate with other enrolled users within the course

3.5. Strategies for the digital transformation of education

The Hungarian digital transformation strategies are consistent with the European agenda. The Digital Education Action Plan (2021-2027) [22] is a renewed European Union (EU) policy initiative that establishes a shared vision of high-quality, inclusive, and accessible digital education in Europe and aims to assist Member States in adapting their education and training systems to the digital age.

The Action Plan, which was adopted on September 30, 2020, is a call for greater European cooperation on digital education to address the challenges and opportunities posed by the COVID-19 pandemic and to present opportunities to the education and training community (teachers, students), policymakers, academia, and researchers at the national, EU, and international levels [22].

The Digital Education Action Plan is a critical enabler for attaining the aim of a European Education Area by 2025. It helps to achieve the objectives of the European Skills Agenda, the European Social Pillar Action Plan, and the '2030 Digital Compass: the European Way for the Digital Decade' [22].

The Digital Education Plan identifies two major priorities and fourteen supporting initiatives [22]:

- Priority 1: Fostering the development of a high-performing digital education ecosystem
    - Action 1: Structured Dialogue with Member States on digital education and skills
        - Proposal for a Council recommendation on the key enabling factors for successful digital education and training
    - Action 2: Council Recommendation on blended learning approaches for high-quality and inclusive primary and secondary education
    - Action 3: European Digital Education Content Framework
    - Action 4: Connectivity and digital equipment for education and training
    - Action 5: Digital transformation plans for education and training institutions
    - Action 6: Ethical guidelines on the use of AI and data in teaching and learning for educators
- Priority 2: Enhancing digital skills and competencies for the digital transformation
    - Action 7: Common guidelines for teachers and educators to foster digital literacy and tackle disinformation through education and training
    - Action 8: Updating the European Digital Competence Framework to include AI and data-related skills
    - Action 9: European Digital Skills Certificate (EDSC)

- Action 10: Proposal for a Council recommendation on improving the provision of digital skills in education and training
- Action 11: Cross-national collection of data and an EU-level target on student digital skills
- Action 12: Digital Opportunity Traineeships
- Action 13: Women's participation in STEM
- Action 14: European Digital Education Hub

The digital transformation of society and the economy has had an ever-increasing impact on daily life, highlighting the need for increased levels of digital capacity in education and training systems and organisations [22].

The COVID-19 epidemic has pushed the already-established trend toward online and hybrid learning. It discovered new and unique ways for students and educators to organise their teaching and learning activities online and engage more personally and freely. Parallel to this, the adoption of digital technologies for education revealed challenges and inequalities between those who have access to digital technologies and those who do not (including people from disadvantaged backgrounds); and challenges related to the digital capacities of education and training institutions, teacher training, and overall levels of digital skills and competences [22].

These changes need a concerted and coordinated effort on the part of the EU to assist education and training systems in addressing the difficulties recognised and exacerbated by the COVID-19 epidemic while presenting a long-term vision for the future of European digital education [22].

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