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Experience of Students at Faculty of Natural Sciences and Engineering, University of Ljubljana in Using Online Classrooms

Izkušnja študentov Naravoslovnotehniške fakultete Univerze v Ljubljani pri uporabi spletnih učilnic

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Abstract

The aim of the study was to determine the progress in the use of online classrooms, gather opinions on their functional use on computers or mobile devices, on user interface and its elements, work within online classrooms, and on the advantages and disadvantages of conducting examinations in online classrooms. The research involved students from various study programmes, including students of textile and clothing study programmes, and focused on analysing the use of Moodle online classrooms through the system's built-in tools and student surveys. The results indicate that the number of users of online classrooms is increasing. Students access online classrooms via computers and, increasingly, via mobile devices. The overall appearance of online classrooms was assessed as appropriate on both computers and mobile devices, with some comments suggesting improvements in the personalisation of the dashboard and better visual organisation. Students were satisfied with the arrangement and accessibility of control elements on both types of devices and praised the typography used, while expressing less satisfaction with some of the icons representing certain functions. Remarks were also made regarding the unclear labelling of some functions or commands. The information displayed on both devices was considered visible, although its retrieval on mobile devices was perceived as time-consuming. Students reported becoming familiar with the online classroom quickly and appreciated their practicality. They were satisfied with the organisation of content by chapters. A smaller number of students uses the online classroom for exchanging opinions or group work, while they still prefer email communication for interaction with lecturers. Students praised the simplicity of submitting assignments via the online environment (esp. group assignments) and the opportunity to receive feedback from assessors. They did not encounter major difficulties when taking exams within the online classroom. They found the technical implementation straightforward, the information provided in the examination (quiz) environment useful, and the appearance of the exam interface pleasant. The findings of the study indicate the need for improvements primarily in the area of the user interface and in encouraging greater use of tools that enable

direct communication among participants within online classrooms. It is also recommended that the faculty provide targeted professional training for academic and technical staff in the advanced functionalities of Moodle, promote the inclusion of interactive and collaborative learning activities, establish coherent pedagogical guidelines for online course design, systematically collect and apply user feedback, and encourage the use of digitally supported forms of teaching.

Keywords: engineering, natural sciences, online classroom, Moodle, digitisation, user experience

Izvleček

Cilj raziskave je bil ugotoviti napredek pri uporabi spletnih učilnic, zbrati mnenja o funkcionalni uporabi spletnih učilnic na računalnikih ali mobilnih napravah, uporabniškem vmesniku in njegovih elementih, delu v spletnih učilnicah ter o prednostih in slabostih izvajanja izpitov v spletnih učilnicah. V raziskavo so bili vključeni študenti različnih študijskih programov (tudi študenti tekstilstva), osredotočala pa se je na analizo uporabe spletnih učilnic Moodle z uporabo vgrajenih orodij sistema ter anket med študenti. Rezultati kažejo, da število uporabnikov spletnih učilnic narašča. Do učilnic dostopajo s pomočjo računalnikov in v vedno večjem številu tudi s pomočjo mobilnih naprav. Splošni izgled učilnic je tako na računalnikih kot mobilnih napravah ocenjen kot ustrezen z nekaterimi opombami glede personalizacije nadzorne plošče in boljše preglednosti. Študenti so bili zadovoljni z razporeditvijo in dostopnostjo kontrolnikov na obeh napravah, pohvalili so uporabljeno tipografijo, manj zadovoljni pa so bili z uporabljenimi ikonami za nekatere funkcije. Podane so bile tudi opombe na nerazumljivo poimenovanje nekaterih funkcij/ukazov. Informacije na zaslonih obeh naprav so bile ocenjene kot vidne, njihovo iskanje na mobilnih napravah pa zamudno. Študenti so se v spletnih učilnicah hitro znašli, pohvalili pa so tudi njihovo praktičnost. Zadovoljni so bili z razporeditvijo vsebin po poglavjih. Manjše število študentov spletno učilnico uporablja za izmenjavo mnenj ali skupinsko delo, za interakcijo z učiteljem pa še vedno raje uporabljajo e-pošto. Pohvalili so enostavnost oddajanja nalog v spletno učilnico (predvsem skupinskih nalog) ter možnost povratne informacije ocenjevalcev. Večjih težav pri opravljanju izpitov v spletni učilnici niso zaznali; tehnična izvedba se jim je zdela preprosta, informacije v izpitnem okolju (kvizu) uporabne, izgled izpita pa prijeten. Ugotovitve raziskave nakazujejo nujnost izboljšav predvsem na področju uporabniškega vmesnika in večjega spodbujanja uporabe tistih orodij, ki omogočajo neposredno komunikacijo med udeleženci v spletnih učilnicah. Priporočljivo je tudi, da fakulteta izvaja ciljno usmerjeno strokovno usposabljanje za visokošolske in tehnične sodelavce na področju naprednih funkcionalnosti sistema Moodle, spodbuja vključevanje interaktivnih in sodelovalnih učnih dejavnosti, vzpostavi usklajene pedagoške smernice za spletno načrtovanje predmetov, sistematično zbira in uporablja povratne informacije uporabnikov ter spodbuja uporabo digitalno podprtih oblik poučevanja.

Ključne besede: inženirstvo, naravoslovje, spletna učilnica, Moodle, digitalizacija, uporabniška izkušnja

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1   Introduction

The digital transformation of higher education has reshaped the ways in which knowledge is created, communicated and evaluated, presenting universities around the world with both challenges and opportunities. In the European and broader international context, higher education institutions have adopted digital education strategies to improve the quality of teaching, expand access to knowledge and learning, and promote sustainable innovation in pedagogical practices [1, 2]. Digital transformation is not just a technological shift, but a comprehensive pedagogical and institutional transformation that redefines the

processes of teaching, learning and assessment. Research emphasises that digital technologies enable greater flexibility, interactivity and accessibility of the learning process; however, their effective integration depends on the pedagogical and digital competences of educators and adequate institutional support to promote digital innovation [3].

1.1 Theoretical and conceptual foundations of digital pedagogy

The development of digital education has gradually shifted focus from the functional introduction of technologies to a more in-depth understanding of learners' experiences, promoting inclusion and sustainable practices. Theoretical approaches such as constructivism and self-regulated learning [4], and models such as the Technology Acceptance Model (TAM) [5, 6] offer guidance for understanding how individuals adopt and use educational technology. The TAM model emphasises perceived usefulness and ease of use as key factors influencing users' behavioural intentions – a perspective that has been repeatedly confirmed in the higher education context, including in the studies on the use of the Moodle online classroom system [7].

Approaches based on constructivist and social constructivist pedagogy emphasise that the integration of educational technologies should promote autonomy, collaboration and reflection among learners [4]. These theories place the learner in the centre of the learning process as an active co-creator of knowledge, which is built through interaction with peers, learning content and digital learning environments. Researchers [8] expand on this argument by emphasising that the effective use of digital learning management systems (LMS) requires not only technical competences but also a comprehensive understanding of didactic and technological pedagogical content knowledge (TPACK model). Their findings are based on an extensive study conducted among 640 higher education teachers, which shows that LMS platforms are often used primarily as repositories for materials rather than comprehensive support environments

for collaborative learning, implementing formative knowledge assessment and providing feedback.

Furthermore, the digital transformation in education must be aligned with the development of digital competences among both students and educators [9]. The European Commission's Action Plan for Digital Education emphasises this alignment and calls for the improvement of digital literacy, equal access and lifelong learning through inclusive educational ecosystems [1, 2]. Studies in recent years have shown that educators need dedicated time, professional support and opportunities for collaborative learning to effectively integrate educational technologies into their teaching [3].

1.2 User experience in digital learning environments

A growing body of literature explores the user experience (UX) of teachers and learners in digital learning contexts. User experience encompasses usability, engagement, satisfaction, interest and perceived learning effectiveness in digital learning environments. Research at European universities has shown that the quality of the digital user experience depends on institutional support, intuitive interface design and the alignment of tool use with pedagogical goals [10]. The rapid transition to online and blended learning during the COVID-19 pandemic has further highlighted differences in digital readiness and emphasised the need for robust, user-friendly learning environments [11].

Moodle, as one of the most widely used online learning environments in the world, has been the focus of studies examining user experience and learning outcomes. Researchers [12] showed that patterns of student engagement captured by Moodle analytics can predict academic performance, highlighting the potential of learning analytics for personalised feedback and early intervention. Similarly, studies on personalisation and adaptive learning paths in Moodle environments [13] reveal the importance of designing flexible, student-centred experiences that respond to the diverse learners' needs.

Recent empirical studies have expanded the analysis of online learning contexts beyond technological possibilities to include social and psychological dimensions. Lavidas et al. [14] examined how social desirability influences students' self-evaluation in different learning environments and showed that contextual factors such as learning mode (lectures versus laboratory exercises) shape students' perceptions and engagement patterns. In a related study, Lavidas, Petropoulou et al. [15] identified factors that influence the level of teacher response in online environments, highlighting authority, incentives and environment structure as determinants of digital collaboration and engagement. These findings are important for explaining user behaviour in online classrooms.

1.3 Moodle in context of digital education

In the broader context of educational technologies, Moodle occupies a special place as an open-source learning management system based on constructivist pedagogy. Its modular architecture allows educators to design learning environments that combine tools for communication, collaboration and assessment [4]. Moodle's openness and flexibility have enabled its widespread institutional adoption, allowing universities to tailor the platform to local pedagogical and linguistic needs [5].

Comparative analyses of LMS platforms such as Blackboard, Canvas and Sakai consistently rank Moodle among the most flexible and cost-effective systems for higher education institutions [10]. Its pedagogical capabilities include asynchronous and synchronous communication, collaboration spaces (forums, wiki pages and workshops), tools for formative and summative assessment, and detailed analytics for tracking student progress [12]. Furthermore, Moodle's open-source ecosystem encourages continuous community-driven innovation, which is consistent with institutional goals of sustainability and academic autonomy.

At the same time, research warns that Moodle's potential remains untapped when its implementation focuses primarily on administrative functions rather than promoting student-centred learning [8]. The pedagogical challenge therefore lies not in technological capabilities, but in designing learning experiences that encourage interaction, reflection and authentic assessment. This is consistent with the findings of North American and Western European universities, where the strategies for introducing digital technologies increasingly emphasise the design of learning and the competences of educators rather than simply introducing platforms [16].

1.4 Institutional context and rationale for the study

In Slovenia, the University of Ljubljana (UL) has committed to a systematic digital transition, guided by its Digital Strategy 2024–2027, which aims to improve the quality of teaching, research capabilities and social engagement through the use of digital technologies [17]. The Digital Strategy is aligned with the European vision of inclusive and sustainable digital education. Its goal is to strengthen the quality of teaching through the systematic development of digital competences among students and staff, while ensuring equal access and innovative pedagogical practices. The Faculty of Natural Sciences and Engineering is part of this process, as it systematically integrated Moodle into its study programmes back in 2017 as part of the institutional project Digital UL – Towards Excellence through Innovative Use of ICT [18], [19]. This integration has enabled the creation of a unified and secure learning environment accessible to all faculty members and students, for which teachers and students have also been provided with training and individual support.

Based on the university's strategic commitment, further development projects between 2021 and 2024 within the framework of the Development Pillar of Funding (RSF) and the ULTRA project for a sustainable society have encouraged the upgrading the use of Moodle online classrooms through interactive content, innovative assessment and collaborative learning activities. These initiatives directly respond

to international evidence that effective digital transformation requires ongoing institutional support, educator training and user-centred design [3, 10].

Accordingly, this study explores the experiences of students at the Faculty of Natural Sciences and Engineering in using Moodle-supported online classrooms. More specifically, it explores the perception of usability, communication, collaboration and assessment within the platform to identify both the strengths and challenges of current practice. By placing local findings within global discussions on digital pedagogy and user experience, this research contributes to the understanding of how institutional strategies can transform technological infrastructure into meaningful learning.

2   Methodology

The data on the use of online classrooms were for research purpose collected in two ways, i.e. by using built-in tools that allow administrators to capture data and with a student survey conducted at the end of an academic year among the students of all bachelor's and master's degree study programmes at the Faculty of Natural Sciences and Engineering, University of Ljubljana (UL NTF).

1.5   Data collection using Moodle built-in tools

The UL NTF online classrooms are hosted on the Moodle platform managed by the Digital Centre UL (https://ucilnica-ntf.uni-lj.si/). Classrooms are available for all courses entered into the UL NTF student information system (VIS). The classrooms are synchronised daily with the VIS system, ensuring up-to-date and automatically synchronised data. The automatic synchronisation allows *inter alia* for the automation of online classroom creation, content transfer and storage, and enrolment of students and course instructors.

The collection of statistical information for analysing the usage of Moodle virtual classrooms and its features to compare the academic years 2022/2023

and 2023/2024 was conducted using built-in tools (i.e. course usage statistics, module usage statistics, reports usage and the accessibility toolkit). In both cases, the Moodle version was 4.3 and the PHP version supported was 8.2.19.

1.6   Student survey on use of online classrooms

1.6.1 Instrument origin and validity

The survey on the use of online classrooms was created in the program Arnes 1Ka (Centre for Social Informatics, University of Ljubljana). The student survey was adapted from the COLLES (Constructivist On-Line Learning Environment Survey) framework [20], which is a well-established instrument, validated internationally across higher-education contexts to assess relevance, reflection, interactivity, tutor support, peer support and interpretation within Moodle environments. We maintained its core construct structure and translated/adapted individual items to fit the context of the Faculty of Natural Sciences and Engineering (UL NTF). Validity and testing were conducted in earlier pilot phases (2019–2021), with a smaller cohort of students already being experienced in using Moodle. Feedback from those pilots informed wording adjustments and section sequencing in the final version used for 2022/2023 and 2023/2024 data collection.

1.6.2 Structure of student survey

The survey comprised 24 questions divided into sections, the description of which follows below.

- After the opening address, the participating students were asked whether they had used an online classroom during the academic year in question. The students who had not used online classrooms (0.6% in the academic year 2022/2023 and 3.0% in the academic year 2023/2024) were redirected to the end of the survey as they did not have the relevant experience to complete the survey in full.

- Students who had used the online classroom continued the survey to the next section, where

they were asked whether it was the first time they had used the online classroom. Those who did not use the online classroom for the first time ticked the number of courses they had used it for, after which they answered an open-ended question about the purpose for which they had used it.

- This was followed by two similar sections on the appearance and user experience of using online classrooms on a computer or mobile device (phone, tablet). In both cases, students indicated their agreement with the statements on a five-point Likert scale (1 – strongly disagree, 2 – disagree, 3 – neither agree nor disagree, 4 – agree, 5 – strongly agree), and optionally entered comments about the user interface of the online classroom they accessed on a computer or mobile device.

- This was followed by a section on the distribution of content or materials in the online classroom. Students again indicated their agreement with the statements on a five-point Likert scale and, if they wished, wrote a comment in an open-ended question.

- In the section that followed, students indicated their agreement on a Likert scale with the statements on the possibility to participate in the online classroom. The Likert scale was this time a six-point scale due to the inclusion of the option "we have not used the above mentioned". Students were given the opportunity to write their comments in this section as well.

- Students were also asked about their opinion on the use of the online classroom for the submission and ongoing evaluation of practical courses, project seminars or other types of assignments. Similarly as in prior sections, students first indicated their agreement with various statements on the topic on a six-point Likert scale and were then given the possibility to write their comments in an open-ended question.

- Online classrooms can also be used for exams; hence, we were interested in students' opinions on the final evaluation/assessment in the online classroom (quiz/exam). We again included a six-point Likert scale with different statements and enabled comments.

- This was followed by closed-ended questions to find out whether students had been using other software tools (e.g. Teams, Toom, Wbebx etc.) in addition to the online classroom.

- In the last section, students indicated the study programme they were attending and their gender.

The survey was active from 27 May–27 August 2023 in the academic year 2022/2023 and from 4 January–28 June 2024 in the academic year 2023/2024. Teachers included the link to the survey in the online classroom of their course. Students completed the survey on their own free will. No personal data was collected in the survey.

1.6.3 Target-group refinement and representativeness

Earlier pilot versions involved students from only a subset of programmes (mainly those with longer Moodle experience). The final two-year implementation expanded to include all bachelor's and master's study programmes at UL NTF, thereby encompassing both experienced and first-time users of online classrooms. This progression was intentional – by covering the entire population, the study captures a broader spectrum of digital-competence levels and user experiences, which would not have been observable in the initial, more homogeneous cohorts.

The number of students completing the survey in each academic year is shown in Figure 1. A total of 307 students participated in the survey over two academic years, with an average of 22.7% male and 77.4% female students (Figure 1). In the academic year 2023/2023, students from 10 study programmes participated in the survey, and in the following year, students from 15 study programmes of both bachelor's and master's degree study programmes (NB: UL NTF runs 16 bachelor's and master's degree study programmes), 22.9% of students being from

textile and clothing study programmes. The online classroom was used in the academic year 2022/2023 by 99.4% of the students surveyed, with a slight decrease in the proportion in 2023/2024 (97.4%), which may be due to the higher number of study programmes where some teachers do not use the online classroom, but were still included in the survey.
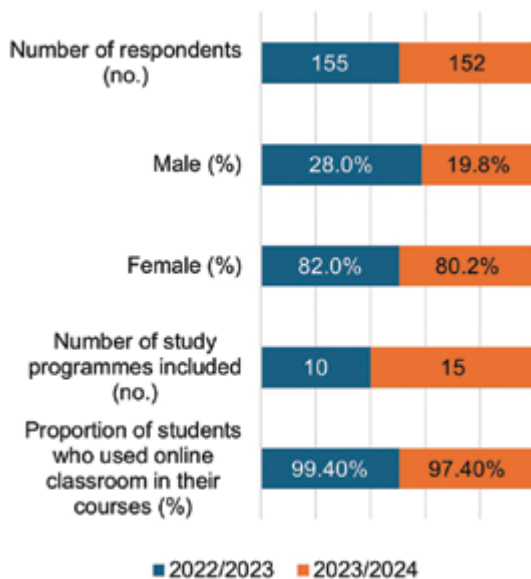

Figure 1: Number of respondents, proportion of respondents by gender and number of study programmes in which survey was conducted in academic years 2022/2023 and 2023/2024

1.6.4 Statistical analysis

Some of the results obtained from the Likert scale (ordinal data) were statistically analysed – the Wilcoxon signed-rank test was used for dependent samples and the Wilcoxon rank-sum test was used for independent samples.

3 Results

1.7 Activities in online classrooms

The data in Table 1, collected using Moodle's built-in tools, show that the number of activities in the academic year 2023/2024 increased compared to 2022/2023, particularly in the uploading files such

as text documents, image materials, videos, presentations etc.

Table 1: Number of activities, files uploaded to Moodle classrooms and users registered with mobile devices in academic years 2022/2023 and 2023/2024

Number of activities/ documents/users	Academic year		Difference (%)
	2022/2023	2023/2024	
Number of activities	4.903	5.413	10.40
Number of files	117.117	173.752	48.36
Word document	1.269	1.752	+38.06
PDF document	15.541	20.985	+35.03
Presentation	534	676	+26.59
Video document	2.055	2.158	+5.01
Audio file	90	88	−2.22
Pictures	32.355	54.517	+15.62
Number of users with registered mobile devices	116	255	119.83

The general trend of mobile device usage is also reflected in the study process (119.83% compared to 2022/2023) as depicted in Table 1.

In the survey, students pointed out that they mainly used online classrooms to review materials uploaded by the teacher (hence the significant increase in uploaded documents to online classrooms in Table 2), to submit seminar papers, project assignments, reports etc., to join groups, take quizzes and

Table 2: Number of used modules in Moodle classrooms in academic years 2022/2023 and 2023/2024

Module	Academic year		Difference (%)
	2022/2023	2023/2024	
File	1446	1942	+34.30
Forum	1028	705	−31.42
Assignment	611	661	+8.18
Folder	337	479	+42.14
URL	377	424	+12.47
Page	292	243	−16.78
Text and media area	209	172	−17.70
Quiz	185	144	−22.16
Book	60	78	+30.00
PDF Annotation	8	75	+837.50
Group choice	28	31	+10.71
H5P	19	30	+57.89
Choice	18	20	+11.11

surveys, participate in forums, take ongoing tests and final exams, to read and receive messages, and to monitor information. Table 2 shows data on the usage of Moodle modules between the academic years 2022/2023 and 2023/2024.

Table 2 shows that in the academic year 2023/2024, there was an increased use of several modules, indicating that teachers started using Moodle online classrooms more regularly. This is particularly evident in the increased number of uploaded files, use of URL links, folders, books, PDF annotations, group selections, H5P and other activities. We can certainly conclude that the effort invested in training and conducting numerous training sessions, online workshops and webinars is paying off, as this not only improves computer literacy among the educational staff but also among all students, technicians and other external collaborators at the Faculty of Natural Sciences and Engineering.

1.8 Student survey results in academic years 2022/2023 in 2023/2024

1.8.1 Basic information on use of online classrooms

The results of the surveys conducted in the academic years 2022/2023 and 2023/2024 are shown below.

Figure 2 shows that the proportion of students using an online classroom for the first time increased in 2023/2024, as did the average number of courses in which students used an online classroom, namely from 4.5 classrooms/student in 2022/2023 (s = 2.04) to 5.2 classrooms/student in 2023/2024 (s = 2.76). The increase in the proportion of first-time users of online classrooms was expected, as teachers of courses that had not used online classrooms before also started using them. Consequently, students then also used online classrooms for the first time.

As already mentioned in the Introduction, the increased use of online classrooms resulted from the active entry of UL NTF into two important projects in 2021 and 2022, i.e. the ULTRA 2.01 project. Both projects included training and workshops for the staff, which contributed to raising the digital com-
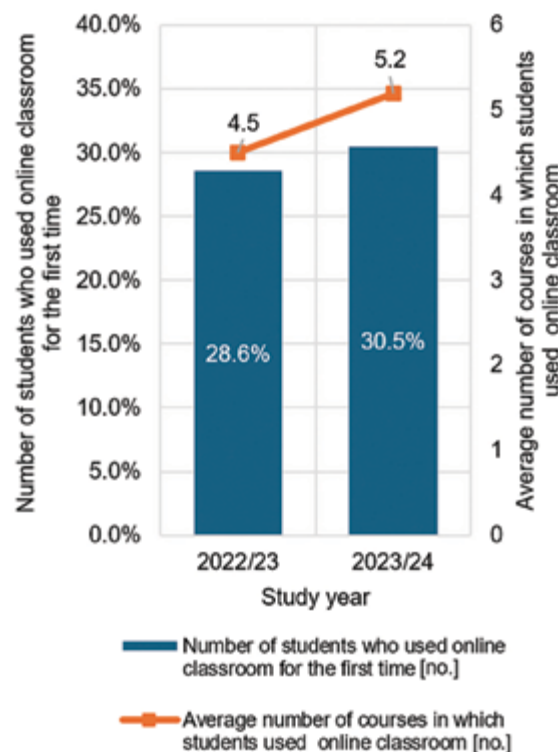

Figure 2: Proportion of students using online classroom for the first time and average number of courses in which students used online classroom in academic years 2022/2023 and 2023/2024

petences of teachers and significantly increased their confidence in using online classrooms.

In addition to online classrooms, teachers also used other software in their courses (Figure 3). They used MS Teams in a higher proportion (the use of this tool even increased by 10.2% in 2023/2024), Zoom for remote conversations (the use of this tool decreased by 25.9% in 2023/2024) and some Google tools such as Drive, Forms etc. We attribute the use of these tools to different reasons. MS Teams was used by the majority of teachers at UL NTF during the Covid era and they got used to it; hence, some of them still do not want to replace this tool with online classrooms. They mainly use MS Teams for uploading materials, meetings and remote consultations etc. They also add that uploading materials by students to MS Teams is easier, since the teacher does not have to open additional functionalities for students to upload files as it is the case in online classrooms
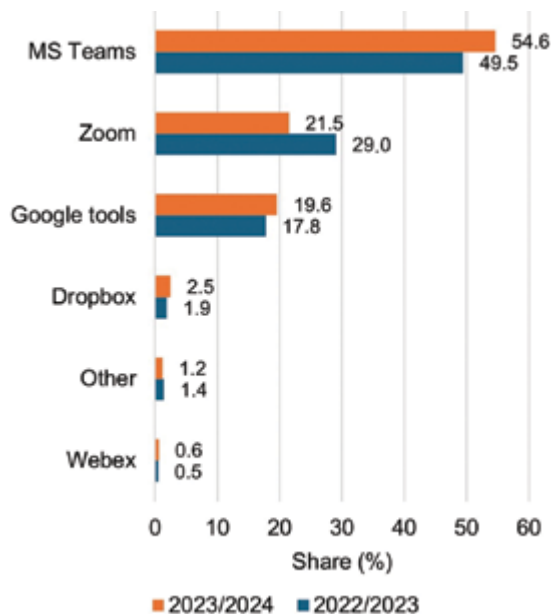
Figure 3: Use of additional software tools in online classrooms in academic years 2022/2023 and 2023/2024

(e.g. assignment etc.). Zoom is mostly used for online meetings and conversations; however, in the last year, it was frequently replaced by MS Teams. Google tools were widely used at UL NTF before the Covid era; nevertheless, their use has been decreasing year by year, being replaced mainly by MS Teams. Other software tools that are still used in very small proportions are Dropbox, Webex, OneDrive and WeTransfer. Although institutional strategies have promoted the integration of online communication within learning management systems, e.g. Moodle, students still prefer communicating with their instructors by email rather than through LMS forums or messaging tools. This pattern appears to be influenced not only by technological usability but also by social and pedagogical factors. Research shows that email is often perceived as a more personal, direct and reliable communication channel, enabling students to receive prompt responses while maintaining a sense of privacy and control. Moodle-based forums are often associated with public exposure and formality, which may discourage students from posting questions visible to peers. In addition, the ergonomic design and notification settings of LMS communication tools

can hinder user engagement. Furthermore, students' habits frequently mirror teachers' own communication practices – when instructors primarily respond by email or fail to model the use of forums, students perceive Moodle as an administrative rather than dialogic environment.

1.8.2 Appearance and user experience of online classrooms on computers and mobile devices (phone, tablet)

As Figure 4 shows, the proportion of students using the online classroom on computers decreased in the academic year 2023/2024 compared to 2022/2023, while online classrooms were more frequently accessed on mobile devices, esp. phones (the increase in the use of online classrooms on phones is also reflected in the data in Table 1).
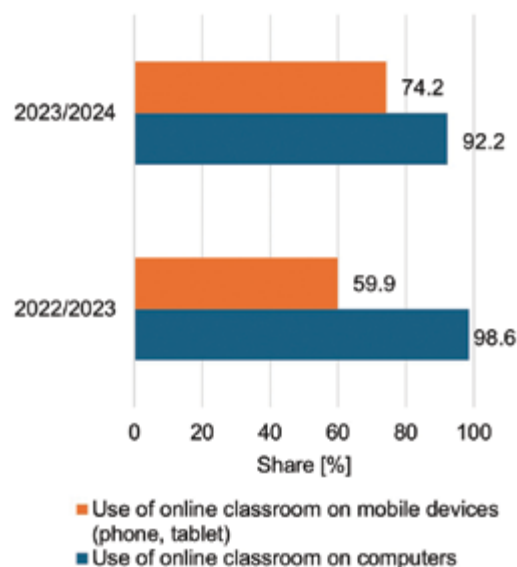

Figure 4: Use of online classrooms on computers or mobile devices (phone, tablet)

In the academic year 2022/2023, the Centre for Digital University of Ljubljana (CDIUL) introduced a new interface for the online classroom, which was to enable easier access and, in particular, viewing content on mobile device. Figures 5 and 6 show the results of the user experience of students who used the online classroom on computers and mobile

devices, respectively. The scores are calculated from the proportions of Likert scale ratings from 1 to 5. In the 2022/2023 survey, 15.9% of respondents answered "neither agree nor disagree" to the questions about the user experience, compared to 17.5% in 2023/2024.
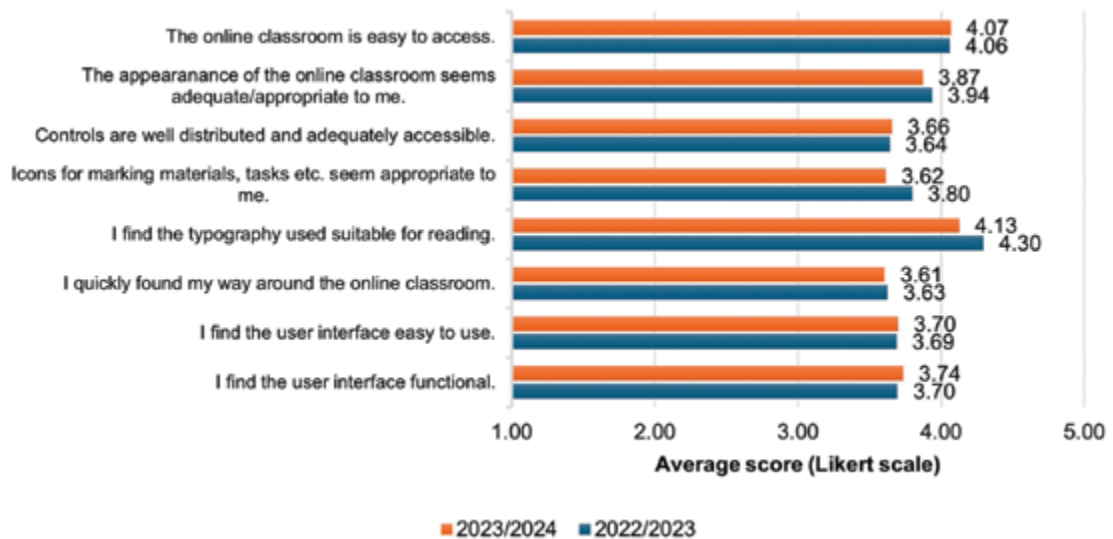

Figure 5: User experience ratings of online classroom on computer (Likert scale: 1 – strongly disagree, 5 – strongly agree)
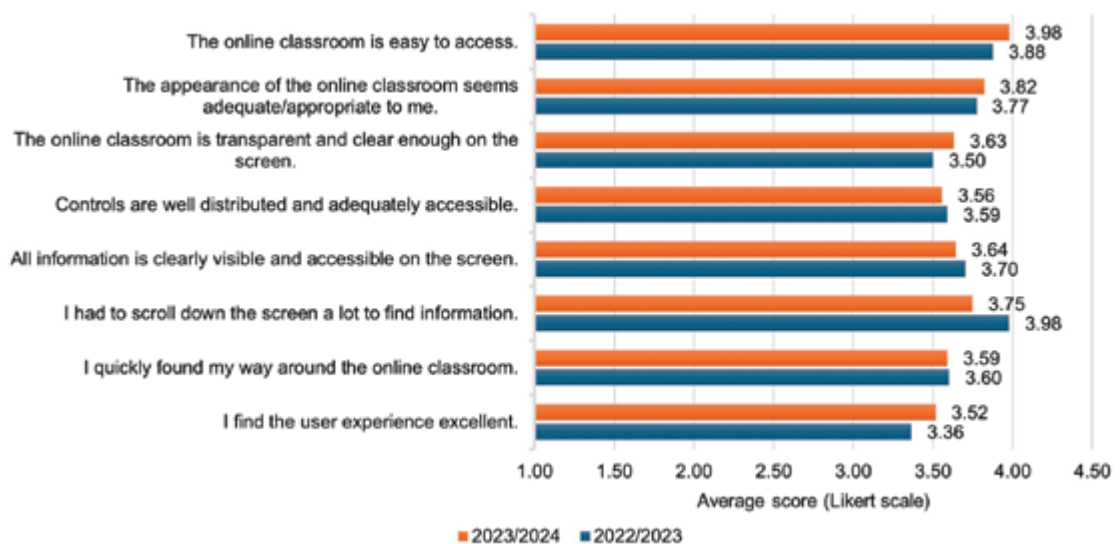

Figure 6: User experience ratings of online classroom on mobile devices, i.e. phone, tablet (Likert scale: 1 – strongly disagree, 5 – strongly agree)

Students found it easier to access the online classroom on a computer than on mobile devices. The results of the Wilcoxon signed-rank test indicated a statistically significant difference in accessibility to the online classroom on a computer and a mobile device for both academic years 2022/23 (Z = −3.01, p = 0.0026, r = −0.6) and 2023/24 (Z = −2.25, p = 0.0242, r = −0.5). Among the comments about the

access on computers, the main difficulty highlighted was the difficulty to access the online classroom on some browsers (e.g. Firefox), while some students had difficulty accessing the online classroom on mobile phones due to the constant reminder to redirect to the Chrome browser.

The online classroom appearance on a computer and on mobile devices was rated by students as adequate/appropriate. However, the results of the Wilcoxon signed-rank test indicated that for the academic year 2022/23, the difference in the online classroom appearance between a computer and mobile device was statistically significant ($Z = -2.89$, $p = 0.0038$, $r = -0.5$), while for the academic year 2023/24, the difference was not statistically significant ($Z = -1.65$, $p = 0.0972$, $r = -0.3$). Therefore, we cannot claim that the users noticed a difference in the appearance of the classroom on a computer or mobile device in the academic year 2023/24. Comments on the online classroom appearance included missing an interface more similar to the Apple experience, wanting more personalisation of the dashboard and better transparency.

Students were satisfied with the layout and accessibility of controls, both on computers and mobile devices. However, the results of the Wilcoxon signed-rank test indicated that for the academic year 2023/24, the difference in the layout and accessibility of controls in the online classroom on a computer and mobile device was statistically significant ($Z = -3.84$, $p = 0.0001$, $r = -0.7$), while for the academic year 2022/23, the difference was not statistically significant ($Z = -1.95$, $p = 0.0506$, $r = -0.3$). Therefore, we cannot claim that the users noticed a difference in the layout and accessibility of controls in the online classroom on a computer or mobile device in the academic year 2022/23. Nevertheless, there was a comment regarding the complex presentation of controls.

Although the reported satisfaction with the icons in the online classroom in 2023/2024 was slightly lower compared to 2022/2023 (a decrease of 4.86%), the Wilcoxon rank-sum test showed that this difference was not statistically significant

($p = 0.106$). A similar trend was observed in the satisfaction with typography, which also decreased slightly in 2023/2024 (by 3.92%). The Wilcoxon rank-sum test indicated no statistically significant difference in satisfaction with the typography used on the computer between the academic years 2022/2023 and 2023/2024 ($p = 0.3792$, $Z = 0.8794$). The decrease in satisfaction may be due to possible changes in the user interface. The evaluated non-statistically significant differences in both cases suggest that the observed decline may reflect normal variability in student responses rather than a significant change in their perceptions of the icons. Among the students' comments, there was a minor dissatisfaction with the terminology used (e.g. the terms "my courses" and "local courses").

While students found the information to be quite visible and accessible on mobile screens, it was relatively time-consuming to get to, requiring a lot of "scrolling". The dissatisfaction with the search process (and also about the difficulty of opening pdf files) increased in 2023/2024 (score was down by 5.78%). The results of the Wilcoxon rank-sum test indicated a non-statistically significant difference in the search process used on the mobile devices between the academic years 2022/2023 and 2023/2024 ($p = 0.0822$, $Z = 1.7381$). Given the small calculated standardised effect size ($r = 0.13$), it would be desirable to obtain a larger sample size per group.

Students agreed that the user interface of online classrooms was functional and easy to use, although a bit more for a computer than mobile devices, and that they quickly found their way around online classrooms. Despite some difficulties, they praised the practicality of online classrooms, as they could access them from anywhere, check new information and, in some cases, receive it to their email address.

1.8.3 Content distribution in online classroom
When evaluating the arrangement of content in the online classroom, it is important to bear in mind that the arrangement of content depends on the administrator (i.e. teacher) of the online classroom to decide

how and in what way to arrange different content. Of course, students' assessment can also be very subjective, as some students may prefer a certain way of arranging the materials more than others. Therefore, the students' comments in this section of the survey were very varied, as indicated below.
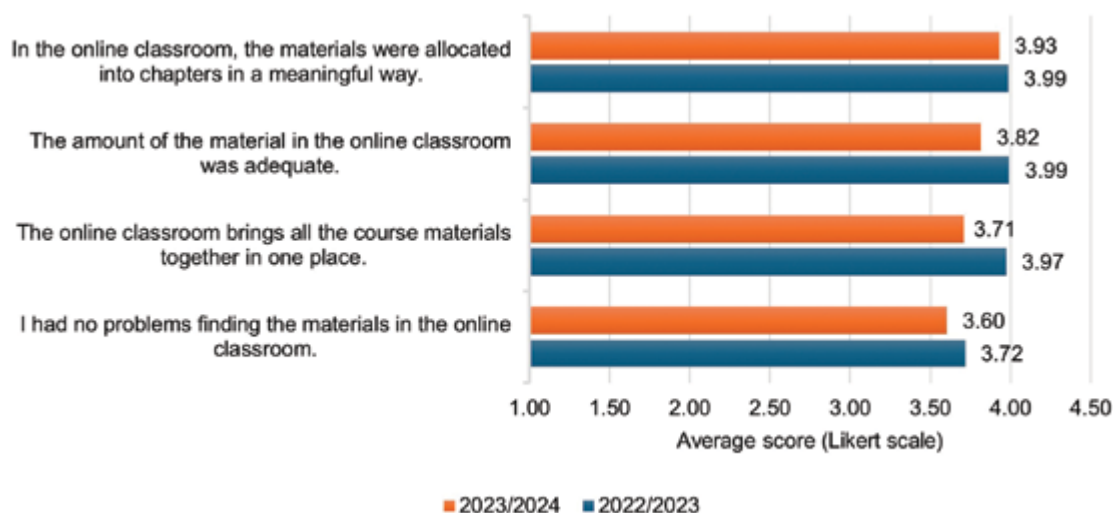

Figure 7: Content arrangement in online classroom (Likert scale: 1 – strongly disagree, 5 – strongly agree)

Figure 7 shows that students were satisfied with the meaningful separation of chapters in both academic years (scores 3.93 and 3.99). They were also satisfied with the amount of material and the possibility to have all the material in one place. We noted that the ratings for these two statements were slightly lower in 2023/2024, which can be attributed to the fact that a number of teachers were new to using online classrooms in this academic year, and may not yet be as proficient, while some were still using a combination of two platforms, e.g. online classroom and MS Teams.

Students gave slightly lower scores for searching for materials in the online classroom. Among the comments that need attention, the majority focused on the online classroom on mobile devices, namely that the presentations were not "clickable" and the already mentioned "scrolling" search on mobile devices (often cited as a problem), which can lead to confusion and lack of clarity as the user gets lost between chapters. Students also mentioned positive features of online classrooms, in particular that the material was in one place and did not have to be searched or downloaded from other platforms and that they would like to see online classrooms in all courses.

The results of the Wilcoxon rank-sum test indicated that no statistically significant differences were found in any of the statements shown in Figure 7 between the academic years 2022/2023 and 2023/2024 ($p > \alpha$; $\alpha = 0.05$). The standardised effect sizes for all statements were small ($r \approx 0.10$–0.30); therefore, increasing the sample size per group would improve the likelihood of reliably detecting such small effects.

1.8.4 Possibility to collaborate (interact with teacher, teaching assistant and peers) in online classroom

Students rated the cooperation options on a five-point scale, where we added the sixth option "we have not used the above mentioned". This also allowed us to obtain for each statement the proportion of students who used tools to interact with the teacher, teaching assistant and peers.

Table 3 shows that in both academic years, students most frequently used the course news monitoring via the forum or notifications uploaded/sent by the teacher. In a much lower proportion, students

used the online classroom for group work, usually for group assignment submissions, peer assessment, comments etc. The online classroom was the least used for exchanging opinions or interacting with the teacher and/or teaching assistant, e.g. via the forum, chat or messaging.

Table 3: Percentage of students who used online classroom collaboration functionalities in academic years 2022/2023 and 2023/2024, and average scores obtained from Likert scale assessment (1 – strongly disagree, 5 – strongly agree)

Interaction possibility within online classroom	Usage percentage (%)		Average score (–) (Likert scale)	
	2022/2023	2023/2024	2022/2023	2023/2024
The online classroom allowed me to keep up to date with news in the course (e.g. via forum, notifications added to the classroom by the teacher and/or teaching assistant).	89.1	86.1	3.88	3.68
The online classroom allowed me to exchange opinions/ ideas (e.g. via forum).	62.5	54.6	3.35	2.88
The online classroom allowed me to interact with the teacher and/or teaching assistant (e.g. via forum, chat, messages).	64.8	62.0	3.32	3.18
The online classroom enabled group work with my peers (e.g. group assignment submission, forum posting, commenting and peer assessment).	76.6	71.3	3.48	3.17

From the average ratings of the interactions given, it is generally observed that the ratings relating to the possibilities to participate in the online classroom are on average lower for all statements given, except for following the course news. Students' comments indicated that they prefer using other platforms/ tools for peer-to-peer communication, while they prefer communicating with teachers by email, as it is perceived to be faster. Nevertheless, students' comments praised the possibility to be informed, as they received messages sent by some teachers from the online classroom to their email addresses (e.g. notifications about assignment due dates, assignment submission, comments on assignments etc.), consequently keeping them up to date with everything that was happening in the course. They would like to be informed from one source rather than several (e.g. higher education student information system – VIS, email, MS Teams, Google applications etc.), which was disruptive in some courses.

The scores for 2023/2024 were lower than the previous year for all statements. We do not have an exact answer as to why the scores decreased; however, we can again assume that both teachers and students had not yet mastered all the collaborative functionalities offered by online classrooms, given that many of them were using the online classroom for the first time.

The results of the Wilcoxon rank-sum test indicated that no statistically significant differences were found in any of the statements shown in Table 3 between the academic years 2022/2023 and 2023/2024 ($p > \alpha$; $\alpha = 0.05$). The standardised effect sizes for all statements were small ($r \approx 0.10$–0.30); therefore, increasing the sample size per group would improve the likelihood of reliably detecting such small effects.

1.8.5 Submission and ongoing evaluation of products of practical courses, seminars, projects or other types of assignments

In the case of the submission and ongoing evaluation of students' work, we also first determined the extent to which the functionality was available to them. Table 4 shows that in both academic years, online classrooms were most frequently used for the submission of assignments completed at practical courses, projects etc. In slightly lower proportions, students also received feedback from teachers and

grades for the assignments submitted in online classrooms. Online classrooms were often used also

for group assignment submissions.

Table 4: Percentage of students who participated in submission and ongoing evaluation functionality of online classrooms in academic years 2022/2023 and 2023/2024

Interaction possibility within online classroom	Usage percentage (%)	
	2022/2023	2023/2024
Ongoing submission of tutorials, seminars, projects and other assignments	95.5	88.1
Teacher and/or teaching assistant reactions to submitted assignments	85.0	75.2
Group submission of assignments at practical courses, seminars, projects	82.0	78.0
Submitting assignments at practical courses, seminars, projects on forum	85.0	74.3
Monitoring grades in the online classroom and performance on required assignments at the course	83.5	78.0

Figure 8 demonstrates that the online classroom is a suitable place to submit the assignments completed at practical courses, seminars, projects and elsewhere. Students also agreed that submitting assignments to the online classroom is easy and that group submission is useful. They also had a similar opinion about the monitoring of assignment grades, which is, according to the score, useful. Students also liked the fact that they could submit assignments to the online classroom on an ongoing basis, as this made it easier for them to meet deadlines and the feedback from the assessors allowed them to improve their products in terms of quality.
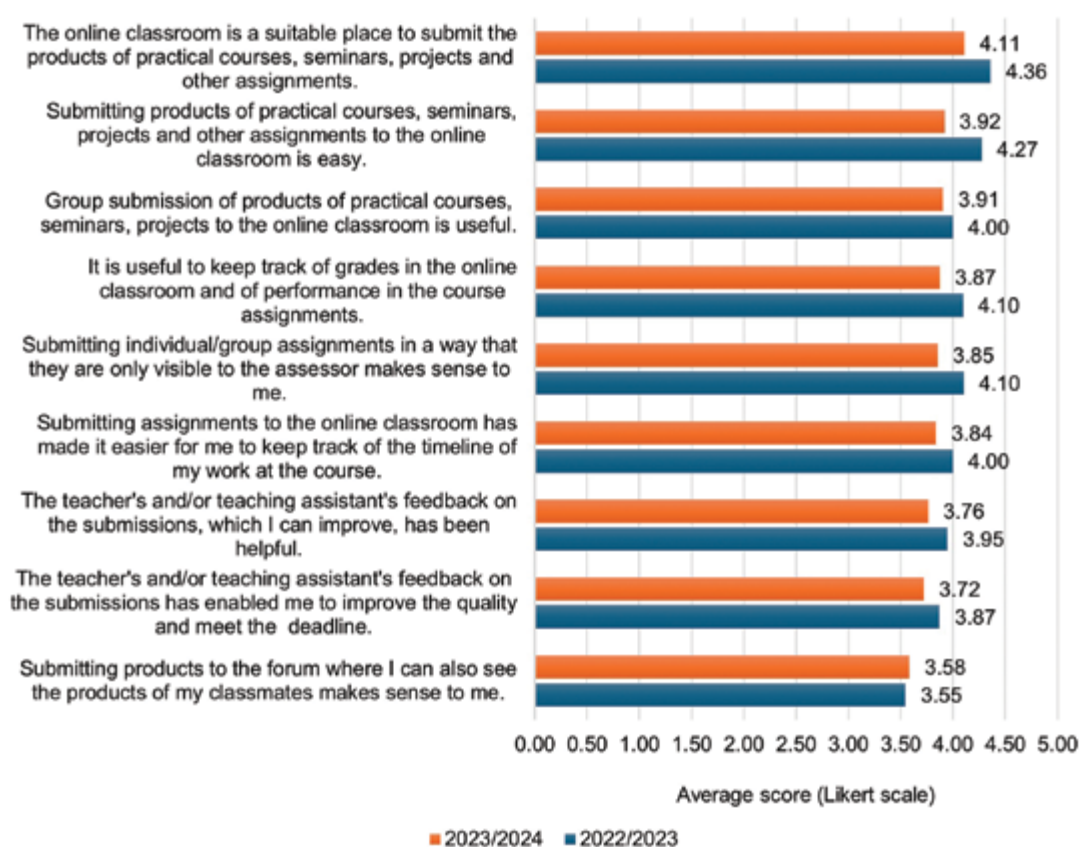

Figure 8: Possibility to participate in online classroom (Likert scale: 1 – strongly disagree, 5 – strongly agree)

Similarly as in the previous case of cooperation, the scores were lower in 2023/2024 compared to the previous year. The online classroom is a place with a number of functionalities to facilitate work, and monitor student work and progress. These functionalities must be mastered by the teacher and brought to the attention of students, who can then build on and complement their work. From the students' comments, we established that teachers often do not review or grade the submitted assignments, and as a consequence, students do not get a response to the products they upload to the online classroom. Due to inappropriate settings, some students failed to submit assignments and some students complained about the amount of unnecessary information in the submission (e.g. too many unnecessary buttons, windows, steps etc.).

On the other hand, positive comments focused on the ease and convenience of submission, while students mostly received assignment grades by email or in person. The calendar, where submission deadlines are written down, and the general up-to-date information on submissions and submission deadlines were praised. The method of group submission was also highly appreciated.

The results of the Wilcoxon rank-sum test indicated that no statistically significant differences were found in any of the statements shown in Table 4 and Figure 8 between the academic years 2022/2023 and 2023/2024 ($p > \alpha$; $\alpha = 0.05$). The standardised effect sizes for all statements were small ($r \approx 0.10$–0.30); therefore, increasing the sample size per group would improve the likelihood of reliably detecting such small effects.

1.8.6 Final evaluation/exam assessment in online classrooms

The online classroom can also be used for final assessments – exams. This functionality, which is implemented via the Quiz plugin, was already used during the Covid era, while after the return back to classrooms, teachers have mostly abandoned this option, due to live exams, also due to the nature of the field of study, being more convenient. It is for the latter reason that the proportion of students who participated in this part was much lower (44.5% of students answered the questions in this part in 2022/2023 and 42.7% in 2023/2024). The rest had no experience with online classroom examinations.
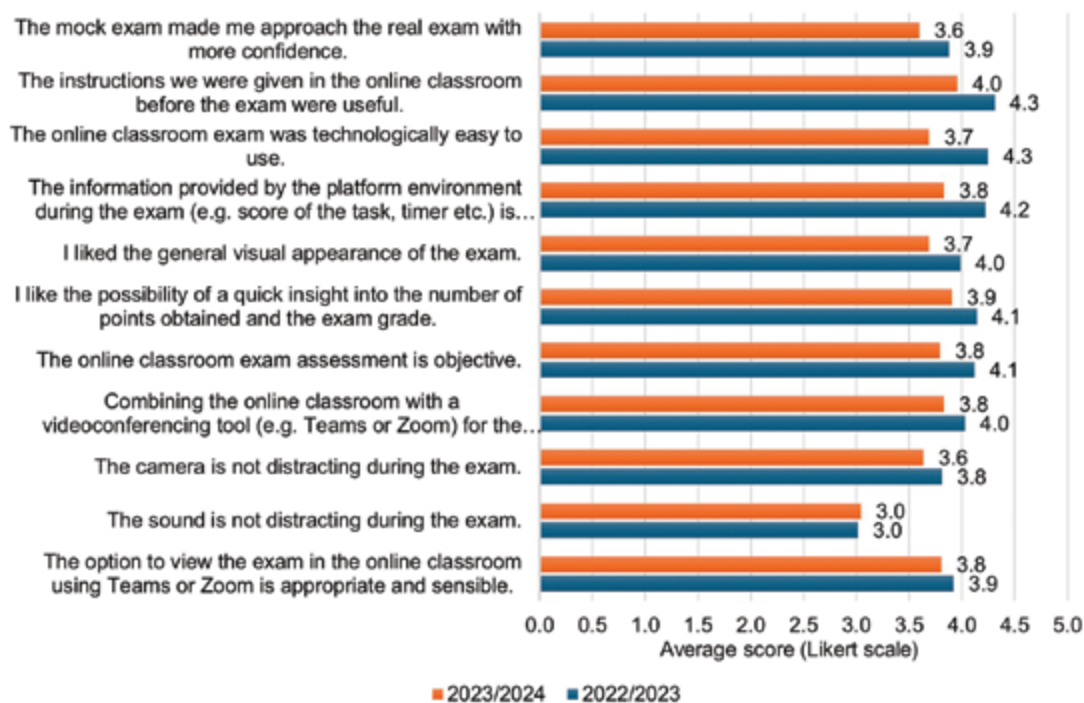

Figure 9: Final evaluation/exam assessment in online classrooms (Likert scale: 1 – strongly disagree, 5 – strongly agree)

As responses in Figure 9 show, students agreed that it is advisable to do a mock exam for the students to get used to the testing environment and the options it offers (moving around the test, type of test questions, re-answer options, question information etc.). The mock exam made students more confident in approaching the real exam.

Students agreed that instructions uploaded by the teacher in the form of a document or a note to the online classroom were useful. The instructions described the exam process, the equipment required to write the exam (e.g. a good internet connection, a working camera and microphone), the rules for writing etc.

Students mostly had no problems during the exam, except for the Firefox browser, which caused some problems (interruptions, inability to access etc.) especially in the academic year 2023/2024. They agreed that the implementation was technologically simple, the information provided by the exam environment (quiz) was useful and that the appearance of the exam itself was pleasant. However, there were a few remarks, e.g. that the names of some of the "buttons" were not understandable or were difficult to link to the function it provided.

The exam requires a combined use of the online classroom with a videoconferencing tool (e.g. MS Teams, Zoom). Students found this combination suitable. They were not disturbed by the camera being switched on during the exam; however, they found the sound more distracting, as they could hear the sounds of typing on the keyboards, possible background noise etc.

Students liked the fact that they had a quick overview of their scores and exam grades after the exam, and they felt that the assessment itself was objective.

Through additional comments, the online classroom was mostly praised, saying that it was a good way of conducting the exam, that it enabled a more relaxed atmosphere etc. However, there were also a few comments that it was easier to write the exam in person, that the exam time was too short and that they were nervous about sitting the exam online.

We noticed that in the academic year 2023/2024, there were fewer negative comments about the implementation of exams in the online classroom environment; however, students did have more problems with the equipment (mainly cameras not working, connecting via phones etc.) and with interruptions of exams mostly due to browser difficulties. The problems with the cameras were exclusively students' problems, while the problem with browsers is a systemic problem that will have to be solved at the level of the technical service.

The results of the Wilcoxon rank-sum test indicated that no statistically significant differences were found in any of the statements shown in Figure 9 between the academic years 2022/2023 and 2023/2024 ($p > \alpha$; $\alpha = 0.05$). The standardised effect sizes for all statements were small ($r \approx 0.10$–0.30); therefore, increasing the sample size per group would improve the likelihood of reliably detecting such small effects.

4 Conclusion

The findings of this study indicate that the digital transformation at the Faculty of Natural Sciences and Engineering has gone beyond the administrative integration of Moodle into course management processes and has begun to influence pedagogical practices at several levels.

The increase in the number of uploaded materials and active classrooms reflects not only administrative compliance but also a growing trend towards blended learning. Students gain continuous access to resources, which supports self-regulated learning and flexible study pacing, a core principle of constructivist pedagogy emphasised in our theoretical framework [4, 8].

High engagement with the Assignment and Quiz modules indicates a gradual move from summative assessment towards formative evaluation. Students' comments highlight that receiving feedback on uploaded work improved the iterative development of projects, supporting reflective and process-oriented learning. This suggests that digital

tools are increasingly used to facilitate continuous assessment loops, consistent with the European Commission's Digital Education Action Plan [1, 2].

While the use of forums and peer-assessment features remains lower than expected, their inclusion in course design demonstrates pedagogical awareness of collaborative learning. Students' remarks that teachers rarely engage in forum-based dialogue underline a need for stronger teaching presence, as proposed in social-constructivist models. These insights reveal that the main challenge is no longer technical implementation, but the pedagogical activation of digital spaces.

Increased mobile device access reflects changing study habits and confirms the importance of inclusive, mobile-first learning design. Students' mixed experiences with interface navigation suggest that UX factors directly influence engagement and motivation, an often-overlooked pedagogical dimension of usability.

The results of online examinations and submission-based tasks indicate that students view digital environments as authentic extensions of classroom learning when clear instructions and transparent grading are provided. This aligns with the TAM model, where perceived usefulness and clarity increase acceptance and learning confidence [7, 5].

As mentioned already, Digital Centre UL has started developing a new user interface for online classrooms. The upgrade is planned as part of the RSF project Unified plug-in and customised interface of online classrooms at the University of Ljubljana, where mentors and students from our faculty are participating. According to the present research, the results obtained can represent the starting point for the redesign and creation of an effective user interface and the creation of an integrated learning environment.

Future studies will examine teachers' technological pedagogical and content knowledge (TPACK) to assess how these competences influence the effective and pedagogically grounded use of Moodle in higher education. They will also focus on peda-gogical outcomes, exploring how improved online classroom design and functionality influence student engagement, learning retention and academic performance, thereby linking digital transformation more directly with educational impact.

Regardless of further research, we can make recommendations for broader and more effective use of Moodle at the faculty, based on the results obtained so far. Recommendations may include systematic training for both teaching and technical staff on more advanced Moodle features, encouraging the use of interactive tools, developing unified pedagogical guidelines for designing online course environments, regularly monitoring student satisfaction and user experience and integrating their feedback, introducing incentives for teachers who actively develop digitally supported teaching etc. Such recommendations would not only strengthen the conclusion but also contribute to more strategic planning of the faculty's future e-learning development.

Data availability statement: The data that support the findings of this study have been openly available in Repository of the University of Ljubljana (RUL) since November 4, 2025: https://repozitorij.uni-lj.si/IzpisGradiva.php?id=175565&lang=eng.

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