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The Analysis of the Moodle Platform E-learning Course Activity at the Faculty of Science and Technology at the University of Silesia

Abstract

The study presents a comprehensive analysis of e-learning course activity on the Moodle platform at the Faculty of Science and Technology, University of Silesia. The primary objective was to evaluate the structure, engagement, and digital resource usage of online courses across various academic disciplines. The dataset, collected prior to the platform's archiving process, included variables such as student enrollment, instructor login frequency, and the size of uploaded teaching materials. Descriptive statistics and non-parametric tests (Kruskal–Wallis, Mann–Whitney U) were employed to assess differences between fields of study and the impact of course visibility on instructor engagement. Additionally, time series analysis using linear regression was conducted to identify trends in course creation and instructor participation from 2012 to 2024.The findings reveal significant disparities in course activity across disciplines, with some fields showing high student numbers and resource intensity, while others exhibited prolonged instructor inactivity. Contrary to expectations, course visibility did not significantly influence instructor engagement. A positive, though marginally significant, trend was observed in both the number of courses and instructor involvement over time, with a notable increase in 2020 due to the COVID-19 pandemic. These insights underscore the need for customised strategies in digital course management, supporting institutional efforts to enhance the quality and sustainability of e-learning environments.

K e y w o r d s: Moodle, e-learning, instructor engagement, course activity analysis, digital education, higher education, non-parametric

Introduction

Over the past decade, universities have faced increasing pressure to deliver digital education that is both inclusive and scalable. European and global policy documents emphasise two priorities: building a high-performing digital ecosystem and strengthening digital competences across the sector (e.g., the EU Digital Education Action Plan 2021–2027; EDUCAUSE Horizon Report 2024). These directions align with the continued use of learning management systems (LMSs), such as Moodle, as institutional backbones for blended and online provision. Sector surveys report both progress and persistent inequalities in students' digital experience (Pasichnyi et al., 2024).

Research on LMS data has evolved from simple click counts to more advanced learning analytics interventions and student-facing dashboards. Recent systematic reviews indicate a shift toward pedagogically informed analytics and improved reporting standards, while also highlighting an over-reliance on behavioural proxies and limited contextualization (Pan et al., 2024; Paulsen & Lindsay, 2024; Bergdahl et al., 2024). Our study addresses these gaps by embedding an institutional Moodle audit within recognised theoretical frameworks and policy contexts.

The development and maintenance of high-quality e-learning courses are essential for ensuring effective knowledge transfer, student engagement, and academic success. Well-structured courses that incorporate multimedia resources, interactive elements, and timely instructor feedback can significantly enhance the learning experience. Conversely, poorly maintained or inactive courses may hinder student motivation and learning outcomes. Therefore, continuous monitoring and evaluation of e-learning environments are crucial for maintaining educational standards and identifying areas for improvement.

This study examines Moodle course activity at the Faculty of Science and Technology, University of Silesia, where the platform is widely used to support teaching and learning. Data were extracted on October 7, 2024, just prior to archiving, to capture the full scope of previous academic years. Data were obtained via a plugin developed by the University's Centre for Online Learning, which aggregated key course-level metadata (e.g., enrolment counts, size of uploaded materials, and instructor login recency) into a dedicated table. The export was anonymised for research purposes. No surveys or interventions were carried out. Ethics approval was not required because the study used anonymised administrative metadata collected under existing regulations and EU law. The analysis followed recognised sector guidelines for learning analytics ethics, and no attempt was made to identify individuals. The research addresses three questions: (1) differences in enrolment and resource size across disciplines, (2) whether course visibility influences instructor activity, and (3) long-term trends in course creation and participation from 2012 to 2024.

By applying descriptive statistics, non-parametric tests, and time series analysis, the study provides valuable insights into the current state of e-learning at the faculty. The findings aim to inform strategic decisions regarding course design, resource allocation, and digital pedagogy, ultimately contributing to the enhancement of the university's online education ecosystem.

Literature review

The development of e-learning environments has become a central focus in modern higher education, particularly in the context of digital transformation and the growing demand for flexible learning models. Learning management systems (LMS) such as Moodle have been widely adopted due to their open-source nature, modularity, and adaptability to various pedagogical approaches (Salam & Farooq, 2020). Moodle supports both asynchronous and synchronous learning, enabling instructors to design interactive, resource-rich courses that can be tailored to meet the diverse needs of students (McCollum, 2020).

A key area of research in e-learning is the design and evaluation of course activities, including student engagement, instructor participation, and the use of digital resources. Studies have shown that instructor presence and timely feedback are critical to maintaining student motivation and course effectiveness (Prince et al., 2020; Kong & Yang, 2024). The importance of instructor activity and course structure in e-learning environments has been widely recognised. However, institutional analyses that compare these factors across disciplines remain limited. These findings are particularly relevant to our investigation of instructor activity and its relationship to course structure and student enrollment (RQ1). Moreover, the volume and quality of uploaded materials – such as multimedia content and structured assignments – are strong indicators of course richness and pedagogical intent (Videla et al., 2021; Garcia, 2022).

The disciplinary context plays a significant role in shaping e-learning practices. Research by Baran et al. (2021) and Hacıoğlu and Gülhan (2021) indicates that fields such as computer science and engineering tend to adopt more interactive and resource-intensive course designs, while humanities and theoretical sciences may rely more on textual content and asynchronous discussion. Such disciplinary differences in course design and pedagogical strategies provide a foundation for our comparative analysis across academic fields (RQ2). Diana and Sukma (2021) emphasise the effectiveness of project-based learning (PBL) in STEM education, while Rehmat and Hartley (2020) highlight the benefits of problem-based learning (PBL) in fostering critical thinking and engineering awareness.

The temporal analysis of e-learning trends has also gained attention. Studies by Attard et al. (2021) and Pe-Than et al. (2022) show that the COVID-19 pandemic accelerated the adoption of digital tools and reshaped teaching practices. This shift has led to a sustained increase in online course offerings and instructor engagement, as confirmed by longitudinal data analyses. These longitudinal shifts in digital education practices support our investigation into temporal trends in course creation and instructor participation (RQ4).

Recent research has also emphasised the importance of microlearning – a strategy that delivers content in small, focused units to enhance retention and engagement. Smyrnova-Trybulska et al. (2022) explored the use of microlearning in programming education, highlighting its potential for automated assessment and personalised learning pathways. Their work demonstrates how microlearning can be integrated into platforms like Moodle to support self-regulated learning and improve digital competencies. Skalka and Benko et al. (2022) further examined the role of gamification and automated feedback in microlearning environments, showing positive effects on student motivation and performance. The operational aspects of course visibility and their potential influence on instructor behaviour remain underexplored, motivating our inquiry into this relationship (RQ3).

Jatnkoon et al. (2025) provided practical case studies of implementing microlearning in higher education, particularly in teacher training and STEM disciplines. These studies confirm that microlearning can be effectively used to enhance digital literacy and pedagogical innovation.

Hackathons and collaborative events have also been recognised as effective tools for experiential learning. Beretta et al. (2022), Longmeier et al. (2022), and Garcia (2022) describe how such events foster teamwork, creativity, and real-world problem-solving skills. These findings align with the broader literature on active learning strategies (Prince et al., 2020; Videla et al., 2021).

Recent reviews synthesise LMS-based learning analytics in higher education. They highlight a gradual shift from descriptive indicators towards interventions and student-centred dashboards, yet also stress methodological weaknesses (limited context, partial reporting, and behavioural proxies only) (Pan et al., 2024; Bergdahl et al., 2024). Reviews of student-facing dashboards indicate a stronger connection to learning sciences and theory-informed design emerging after 2020 (Paulsen & Lindsay, 2024).

To align with broader conversations about e-learning ecosystems, we include recent proceedings that demonstrate how cloud infrastructures and augmented reality co-shape digital learning environments (Papadakis et al., 2023; Papadakis et al., 2024). Although our dataset does not track AR usage, these works situate LMS activity within wider, cloud-enabled innovation trajectories.

In conclusion, the reviewed literature supports the importance of structured, data-informed, and discipline-sensitive approaches to e-learning. The integration of microlearning, active learning strategies, and digital analytics into platforms like Moodle offers promising directions for improving the quality and effectiveness of online education.

The reviewed literature highlights key dimensions of e-learning course design and delivery, including instructor engagement, resource intensity, disciplinary differences, and the impact of digital transformation. However, existing studies often focus on isolated aspects or specific pedagogical interventions, without providing a comprehensive, data-driven comparison across academic disciplines. Moreover, the relationship between course visibility and instructor behaviour remains underexplored, and longitudinal analyses of course activity are still limited. These gaps inform the formulation of our research questions, which aim to investigate structural and behavioural patterns in Moodle-based courses, explore discipline-specific trends, assess the role of course visibility, and identify long-term developments in digital education.

Methodology

This study employs a quantitative, exploratory approach to analyse structural and behavioural patterns in Moodle-based e-learning courses. The methodology was designed to address four research questions (RQ1–RQ4) and test the corresponding hypotheses (H1–H4), formulated to explore broader trends in digital education beyond the scope of a single institution.

Research questions and hypotheses

The following research questions were formulated:

RQ1: What patterns of student enrollment and instructor activity can be observed in Moodle-based courses, and how might these reflect broader trends in course engagement across higher education institutions?

RQ2: How do academic disciplines influence the structure and activity of Moodle courses, and what does this reveal about discipline-specific patterns in digital education?

RQ3: Does course visibility (hidden vs. visible) correlate with instructor activity, and how can this inform course management practices in online learning environments?

RQ4: What long-term trends in course creation and instructor participation can be identified on Moodle platforms, and how do they reflect broader shifts in digital pedagogy over time?

The hypotheses determined based on RQ1-RQ4 are as follows:

H1: Most Moodle courses show low to moderate student enrollment, with substantial variability in instructor activity across courses.

H2: Academic discipline is associated with significant differences in course structure and activity, including student numbers, file sizes, and instructor login frequency.

H3: There is no statistically significant correlation between course visibility and instructor activity.

H4: There is a positive trend over time in both the number of Moodle courses created and instructor participation, with a notable increase during the COVID-19 pandemic.

To achieve this, multiple statistical metrics were computed, and the results were visually represented using column graphs and boxplot graphs.

The dataset was extracted from the Moodle platform used at the Faculty of Science and Technology, University of Silesia. Although institution-specific, the data structure and variables are representative of common Moodle implementations in higher education, making the findings relevant to broader e-learning contexts.

A detailed analysis of the activity of courses delivered via the Moodle platform (el.us.edu.pl/wnst) for students of the Faculty of Science and Technology at the University of Silesia was conducted. The data were collected on October 7, 2024, prior to the course archiving process on the platform. It is important to note that course archiving on the Moodle platform at the University of Silesia is not performed annually, but rather at irregular intervals, typically every few years. As a result, many courses – including those created as early as 2012 – remained accessible in the system until the most recent archiving process in October 2024. This allowed for the extraction of historical metadata such as course creation dates, instructor login records, and file uploads, enabling longitudinal analysis over twelve years. The dataset was obtained from a manually created table in the database, generated using a custom plugin developed by the Centre for Online Learning at the University of Silesia. The table includes information about courses assigned to categories corresponding to current degree programs (formerly institutes).

The dataset includes the following variables for each course:

- Index – sequential course identifier,

- Category (Program) – category in the system corresponding to the academic program: Applied Computer Science, Biophysics, Biomedical Engineering, Chemical Technology, Chemistry, Didactic Offer (General Academic), English Philology, Environmental Protection, Information Security and Security Administration, Informatics, Materials Engineering, Mathematics, Mechatronics, Medical Physics, Micro- and Nanotechnology, Physics,
- Oldest log – the earliest log entry associated with the course ID, treated as the course start date (reconstructed courses retain the original date),
- Last modification date – the date of the last change to course settings (does not include content updates or grading),
- Course start date – the date from which the course is available to students,
- Course end date – the date from which the course becomes unavailable to students,
- Hidden from students – indicates whether the course is visible to students,
- Size of attached files (Bytes) – total size of uploaded files (e.g., PDFs, audio, video),
- Students in the course – number of users enrolled with the “student” role,
- Tutors with editing rights – number of users with the “tutor” role and editing permissions,
- Tutors without editing rights – number of users with the “tutor” role without editing permissions,
- Days since last instructor login – number of days since the last login by a user with the “instructor” role.

To operationalise the research questions, the following assumptions were adopted.

Student enrollment was used as a proxy for potential course engagement (RQ1), acknowledging that enrollment does not guarantee active participation. Due to platform limitations, detailed activity logs (e.g., forum posts, quiz attempts) were not available; therefore, enrollment numbers were used as indicators of course reach and visibility.

Instructor activity was measured by the number of days since the last login by a user with editing rights (RQ1, RQ3). This metric reflects the recency of course maintenance or pedagogical involvement.

Course visibility was defined based on Moodle’s technical setting: whether a course is marked as “hidden” or “visible” to students (RQ3). Hidden courses are typically archived by the teachers, under development, or intentionally restricted, and their presence may reflect institutional practices in course lifecycle management.

Academic discipline was assigned based on course categorisation in the Moodle database (RQ2), allowing for comparative analysis across fields of study.

Temporal trends (RQ4) were analysed using metadata such as the earliest log entry and course creation date, which were preserved in the system even for older courses. This enabled longitudinal analysis from 2012 to 2024.

The study applied descriptive statistics to summarise the dataset and non-parametric tests (Kruskal–Wallis, Mann–Whitney U) to assess differences between groups, given the non-normal distribution of the variables. Spearman's rank correlation was used to examine relationships between selected indicators. Time series analysis using linear regression was conducted to identify long-term trends in course creation and instructor engagement.

This methodological framework supports the investigation of structural and behavioural patterns in e-learning environments. It contributes to the broader understanding of how digital courses are developed, maintained, and utilised across academic disciplines.

Descriptive Statistics

In order to study the structural characteristics of Moodle courses and their relationship with instructor engagement, a descriptive statistical analysis was conducted. The key metrics selected for this analysis were:

- Number of students enrolled in each course,
- Size of uploaded files: teaching materials, students' tasks (converted to kilobytes),
- Number of days since the last instructor login.

These three indicators were chosen as central to the analysis due to their relevance in evaluating course activity and resource intensity. The number of instructors per course is typically one, occasionally two, and very rarely more. Therefore, instructor-related metrics are best interpreted in the context of course-level data.

The descriptive statistics for these variables are presented in Table 1. These values provide insight into the distribution and variability of course engagement and content volume across the faculty.

Table 1.
Descriptive statistics on responses to sociological questions

Statistic	Students	Size_KB	Days_since_login
Count	68606	1504032120.00	1904595
Mean	21.39	468984.13	3207
Std Dev	39.0	1625791.42	509.58
Min	0.0	0.0	0
25%	5.0	9113.60	139.0
50%	13.0	54988.80	493.0
75%	25.0	288460.80	983.5
Max	837.0	39426457.60	1840.0

Source: Own work.

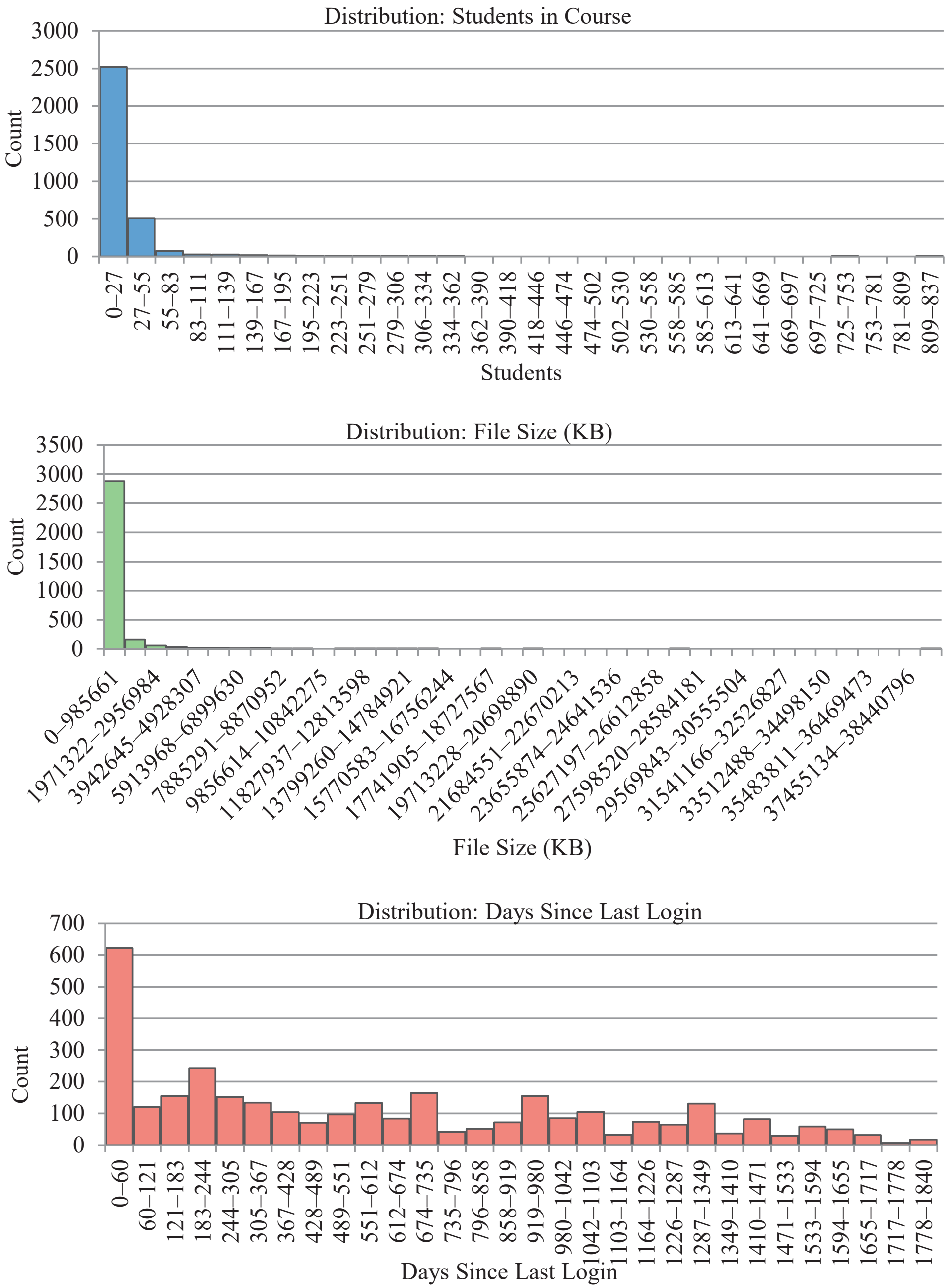

Figure 1. Histograms of the distributions of the three main variables: number of students enrolled in each course, size of uploaded teaching materials (converted to kilobytes), and number of days since the last instructor login.

The analysis of descriptive statistics reveals several important insights into the structure and activity of Moodle courses at the Faculty of Science and Technology. The average number of students per course is 21.39, but the high standard deviation (39.0) indicates significant variability – only a few students attend some courses, while others have enrollments exceeding 200. The average size of uploaded materials is approximately 469,000 kilobytes (about 469 MB), with a wide range from 0 KB to over 1.5 GB. Some courses are either content-rich, possibly including multimedia, large datasets or contain many works submitted by students. On the other hand, some courses may lack substantial materials, and students do not send any reports or projects. The median number of days since the last instructor login is 493, with a minimum of 0 and a maximum of 1840 days. The data indicate that many courses have not been actively maintained for over a year, and some for several years. These findings underscore the importance of regularly auditing course activity and content relevance. Courses with no recent instructor activity, no students, or no uploaded materials may require archiving or removal to maintain the quality and efficiency of the e-learning environment.

It is worth noting that, after these analyses, a comprehensive archiving process for unused courses has already been completed, and the current state of the platform has significantly improved as a result.

Analysis of variable distributions

In order to gain a deeper understanding of the characteristics and activity levels of Moodle courses at the Faculty of Science and Technology, we conducted an analysis of the distributions for three key variables: the number of students enrolled in each course, the size of uploaded materials (converted to kilobytes), and the number of days since the last instructor login. The distributions were visualised using histograms to provide a clear picture of how these variables are spread across all courses. The histograms help identify patterns such as skewness, central tendency, and variability within each variable (Figure 1).

The histogram shows a highly right-skewed distribution with most courses having fewer than 50 students. A small number of courses have enrollments exceeding 200 students. Some courses are very popular, but most have relatively low enrollment numbers.

This histogram also displays a right-skewed distribution with most file sizes concentrated below 500,000 KB (~500 MB). There are a few outliers with file sizes exceeding several gigabytes. While many courses use minimal digital resources, some incorporate extensive multimedia content, large datasets or 3D graphic projects.

The histogram shows a more evenly spread distribution but still exhibits right skewness. A significant number of instructors have not logged into their courses for over a year. This highlights potential issues with course maintenance and instructor engagement over time, or developing new versions of courses for another academic semester.

To assess whether the analysed variables follow a normal distribution, the Shapiro-Wilk test was conducted. This test is particularly suitable for small to medium-sized samples and is commonly used to verify the assumption of normality in statistical analyses.

The hypotheses for the test were as follows:

- H0 (null hypothesis): The variable follows a normal distribution.
- H1 (alternative hypothesis): The variable does not follow a normal distribution.

The results of the Shapiro-Wilk test indicated the following. For the variable representing students, the W statistic was 0.418514, the Z statistic was 18.011805, and the p-value was less than 0.000001. For the variable representing the number of days since the last login, the W statistic was 0.91231, the Z statistic was 13.119826, and the p-value was also less than 0.000001. Similarly, for the variable representing file size in kilobytes, the W statistic was 0.91231, the Z statistic was 13.119826, and the p-value was again less than 0.000001.

Given that, all p-values are significantly lower than the commonly used significance level of 0.05, the null hypothesis was rejected in all cases. This leads to the conclusion that none of the analysed variables follow a normal distribution. The distributions of all variables are strongly asymmetric, which confirms the H1 hypothesis that the majority of Moodle courses show low to moderate student enrollment, with substantial variability in instructor activity across courses.

Analysis of variation between fields of study

To determine whether the field of study significantly influences selected course-related variables, we conducted Kruskal-Wallis ANOVA tests. This non-parametric method is suitable for comparing more than two independent groups when the data are not normally distributed. The analysis included the following variables: number of students enrolled in a course, days since the last login by the instructor, and size of attached files (in KB). The grouping variable was the field of study, categorised into 17 distinct areas: Applied Computer Science, Biophysics, Biomedical Engineering, Chemical Technology, Chemistry, Didactic Offer (General Academic), English Philology, Environmental Protection, Information Security and Security Administration, Informatics, Materials Engineering, Mathematics, Mechatronics, Medical Physics, Micro- and Nanotechnology, Physics and “Other” group for uncategorised entries. The results of the tests are shown in Table 2. These significant differences in all variables among the fields of study confirm the hypothesis H2.

Table 2.
Kruskal-Wallis test results for course variables by field of study

Variable	H-statistic	p-value	eta squared	Interpretation
Students	368.24	< 0.000001	0.14	Significant differences in student numbers across fields of study
Days Since Last Login	156.19	< 0.000001	0.03	Significant differences in login recency across fields of study
File Size (KB)	190.86	< 0.000001	0.05	Significant differences in file sizes across fields of study

Table 3.
Median Values of Course Variables by Field of Study

Field of Study	Median Students	Median Days Since Last Login	Median File Size (KB)
Applied Computer Science	15.0	261.0	31,846.4
Biomedical Engineering	19.0	363.0	131,788.8
Biophysics	7.0	367.0	6,656.0
Chemical Technology	8.0	657.0	37,171.2
Chemistry	10.0	948.0	26,009.6
Didactic Offer (General Academic)	6.5	150.0	61,696.0
English Philology	18.0	1293.5	188,262.4
Environmental Protection	24.0	294.5	78,950.4
Informatics	21.0	513.0	72,704.0
Information Security and Security Administration	49.0	0.0	206,540.8
Materials Engineering	2.0	301.0	34,816.0
Mathematics	14.0	413.0	31,590.4
Mechatronics	11.0	362.0	120,729.6
Medical Physics	8.0	1216.0	27,955.2
Micro- and Nanotechnology	3.0	720.0	8,499.2
Other	15.0	369.0	24,115.2
Physics	2.0	725.0	35,225.6

Table 3 consolidates the median values of the variables: number of students enrolled in a course, days since the last login by the instructor, and size of attached files (in kilobytes). The data are grouped by field of study and sorted alphabetically. This format enables a clear comparison of how these variables vary across academic disciplines.

The results of the Kruskal-Wallis tests reveal statistically significant differences across fields of study for all three analysed variables: the number of students enrolled in a course, the number of days since the last login by the instructor, and the size of attached files. These differences are not random but reflect meaningful distinctions in how courses are structured and managed depending on the academic discipline.

To more deeply visualise the differences between fields of study in the variables analysed, boxplot charts by area of study were prepared in Figures 2, 3, and 4.

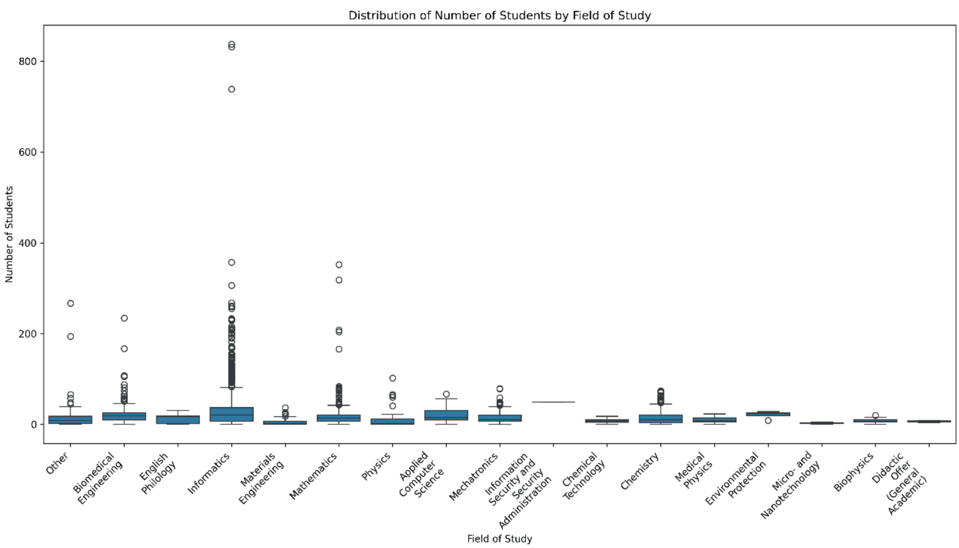

Figure 2. Number of students in courses according to the field of study

In the plot showing the number of students, most fields exhibit moderate enrollment levels. However, Information Security and Security Administration stand out with exceptionally high outliers, reaching nearly 800 students in some courses. Certain programs attract significantly larger groups, possibly due to their relevance, popularity, or mandatory status, or are maintained for a long period and attended by many students across multiple years. Other fields, such as Mathematics, Physics, and Materials Engineering, show tighter distributions, indicating more consistent class sizes across courses.

To enhance precision and support robust comparisons, 95% confidence intervals for the mean number of students per course were calculated for each discipline using bootstrap resampling methods:

Applied Computer Science: CI 17.26 to 26.67 students

Biomedical Engineering: CI 18.10 to 21.99 students
Biophysics: CI 4.78 to 12.33 students
Chemical Technology: CI 6.97 to 8.52 students
Chemistry: CI 13.20 to 16.33 students
Didactic Offer (General Academic): CI 4.00 to 9.00 students
English Philology: CI 6.83 to 17.59 students
Environmental Protection: CI 13.73 to 27.25 students
Informatics: CI 31.35 to 39.35 students
Information Security and Security Administration: CI 25.00 to 49.00 students
Materials Engineering: CI 3.66 to 5.13 students
Mathematics: CI 16.13 to 21.05 students
Mechatronics: CI 13.62 to 16.46 students
Medical Physics: CI 7.69 to 11.83 students
Micro- and Nanotechnology: CI 1.20 to 4.20 students
Other: CI 11.24 to 18.86 students
Physics: CI 6.34 to 22.37 students

These results demonstrate that technical and engineering disciplines tend to have a higher average student participation and greater volume of digital learning materials compared to other fields. This observation is consistent with existing frameworks of institutional digital maturity and technology acceptance models which emphasise the role of discipline-specific digital engagement patterns in shaping e-learning ecosystems.

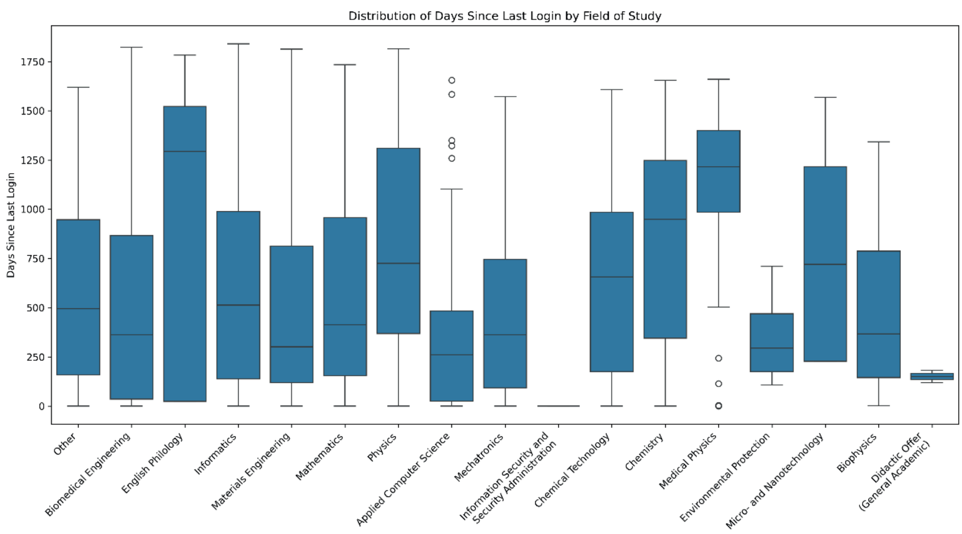

Figure 3. Number of days since last login according to the field of study

The file size distribution reveals that courses in Information Security, English Philology, and Biomedical Engineering often include very large files, with some exceeding 2 GB in size. These outliers may reflect the use of multimedia content, extensive documentation, bundled resources, including tasks done by students and uploaded into the system. In contrast, fields like Biophysics and Micro- and Nanotechnology tend to have smaller file sizes, suggesting more concise or less resource-intensive materials.

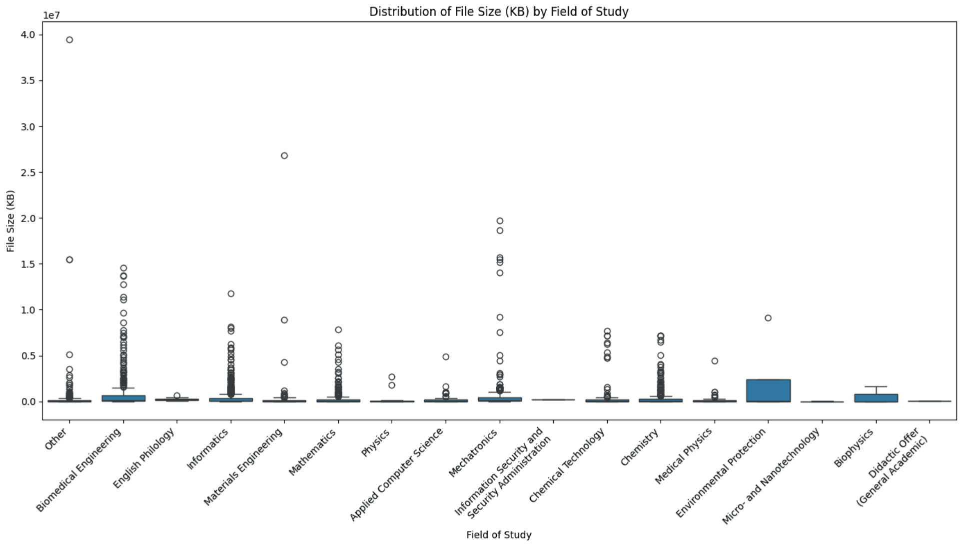

Figure 4. File size (KB) according to the field of study

The third plot, focusing on days since last login, highlights significant disparities in instructor engagement. While Information Security shows a median of zero days – indicating very recent activity – fields such as English Philology, Medical Physics, and Chemistry include outliers where instructors have not logged in for over 1200 days. This could point to abandoned or archived courses, or a lack of ongoing updates, showcasing that in some disciplines, the interest in distance learning happens only during special situations like a pandemic. Fields with more uniform distributions, such as Mathematics and Informatics, suggest regular maintenance and consistent teaching activities.

To enhance precision and support robust comparisons, 95% bootstrap confidence intervals for the mean were estimated per discipline for the number of days since last login and the file size. The results are as follows:

Applied Computer Science: file size CI 80.6 million to 235.1 million bytes; login days CI 267 to 511 days.

Biomedical Engineering: file size CI 132.2 to 176.8 million bytes; login days CI 472 to 573 days.

Biophysics: file size CI 2.3 million to 509.2 million bytes; login days CI 206 to 855 days.

Chemical Technology: file size CI 66.7 to 120.5 million bytes; login days CI 532 to 717 days.

Chemistry: file size CI 71.8 to 107.7 million bytes; login days CI 769 to 877 days.

Didactic Offer (General Academic): file size CI 52.1 to 74.2 million bytes; login days CI 119 to 181 days.

English Philology: file size CI 135.3 to 338.8 million bytes; login days CI 522 to 1334 days.

Environmental Protection: file size CI 1.15 million to 116.7 million bytes; login days CI 153 to 582 days.

Informatics: file size CI 139.6 to 168.4 million bytes; login days CI 567 to 632 days.

Information Security and Security Administration: file size CI 5.2 million to 211.5 million bytes; login data flagged as missing or invalid.

Materials Engineering: file size CI 89.1 to 137.1 million bytes; login days CI 451 to 599 days.

Mathematics: file size CI 112.1 to 152.1 million bytes; login days CI 526 to 611 days.

Mechatronics: file size CI 139.4 to 201.4 million bytes; login days CI 424 to 529 days.

Medical Physics: file size CI 51.7 to 172.2 million bytes; login days CI 948 to 1248 days.

Micro- and Nanotechnology: file size CI 2.5 to 15.3 million bytes; login days CI 326 to 1258 days.

Other: file size CI 81.7 to 134.0 million bytes; login days CI 511 to 638 days.

Physics: file size CI 26.5 to 57.7 million bytes; login days CI 624 to 976 days.

Technical and engineering disciplines, such as Informatics, Applied Computer Science, and Biomedical Engineering, tend to have larger digital resource volumes, with moderate to high instructor activity reflected by login recency. Humanities and general academic disciplines show wider variability in both metrics, suggesting more diverse or intermittent use of e-learning resources. The wide confidence intervals in some fields (e.g., Biophysics, English Philology) point to heterogeneous teaching practices and course structures within those disciplines. These results provide nuanced insight into discipline-specific digital engagement patterns within the Moodle e-learning environment.

Taken together, these plots illustrate how different academic disciplines vary not only in student participation but also in digital resource usage and instructor involvement. Courses with high outliers in student numbers and file sizes may require additional platform support or optimisation. At the same time, those with long login delays might benefit from administrative review or re-engagement strategies.

These insights can inform decisions about course design, resource allocation, and institutional priorities.

In terms of student enrollment, the highest median values were observed in fields such as Information Security and Security Administration, Environmental Protection, and Informatics, suggesting that these areas tend to attract larger student groups. In contrast, fields like Physics and Materials Engineering had the lowest median enrollments which may indicate more specialised or less populated programs.

The variable representing instructor activity, measured by the number of days since the last login, also varied considerably. Fields such as English Philology and Medical Physics showed the longest periods of inactivity, with medians exceeding 1200 days, while Information Security and Security Administration stood out with a median of zero, indicating very recent or ongoing engagement. This may reflect differences in course delivery models, administrative oversight, or the frequency of updates required in each field.

File size medians further highlight disparities in course content or resource intensity. The largest files were associated with Information Security, English Philology, and Biomedical Engineering, potentially pointing to more extensive use of multimedia, documentation, or data-heavy materials. In some cases, students have created large course sizes by submitting their works, including videos or 3D projects which consume significant server disk space. Also, there are courses which were reused over the years by new students uploading their tasks, resulting in many old, unnecessary files in the course. On the other hand, fields like Biophysics and Micro- and Nanotechnology had much smaller file sizes, which could suggest more concise or less resource-intensive course formats. There were courses containing only quizzes or final assignments for students, especially those created during the pandemic period.

Spearman's rank correlation coefficients were computed between file size (in bytes), number of instructors with editing rights, and days since the last instructor login (a proxy for recency of activity). The matrix revealed a small positive correlation between file size and number of instructors: 0.062, suggesting courses with more instructors tend to have slightly larger digital resources. There was a very weak negative correlation between file size and days since last login: –0.015, indicating that larger courses show a tendency for more recent instructor activity, though the relationship is minimal. Additionally, a small negative correlation was found between the number of instructors and days since last login: –0.043, implying that courses with more instructors generally have marginally more recent logins.

Overall, the findings underscore that the academic field significantly influences how courses are populated, maintained, and resourced. These insights can inform decisions related to platform optimisation, resource allocation, and instructional design tailored to the specific needs and behaviours of different disciplines.

Course visibility analysis

The focus of analysis in this section is on the relationship between course visibility on the Moodle platform and instructor activity and other factors. The goal was to see whether hiding a course from students affects the frequency with which instructors log in and changes over time. The data were divided into two groups: visible courses and hidden courses. The Kruskal-Wallis non-parametric test was used due to the non-normal distribution of the variable number of days since the last login. The research hypotheses were defined as follows:

- H0 (null hypothesis): Course visibility does not affect instructor activity.
- H1 (alternative hypothesis): Hidden courses differ significantly in terms of instructor activity.

Given that, the data did not follow a normal distribution and the comparison involved two independent groups, the Mann-Whitney U test – a non-parametric alternative to the t-test – was applied. The test compared the distribution of login activity between hidden and visible courses. The results of the test were as follows: U statistic: 1,243,805.0, p-value: 0.502.

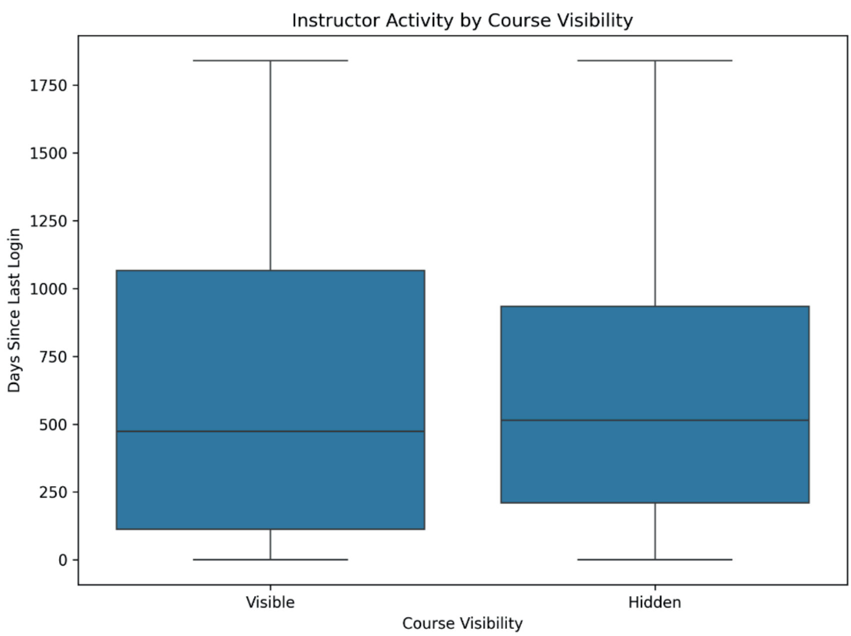

Figure 5. Instructor activity by course visibility (Days since last login)

Since the p-value is substantially greater than the conventional significance level of 0.05, we fail to reject the null hypothesis. This means that there is no statistically significant difference in instructor activity between hidden and visible courses, which confirms the H3 hypothesis. In practical terms, whether a course is hidden from students or not does not appear to influence how recently instructors have logged into the system. This finding suggests that course visibility is not a reliable indicator of instructor engagement, and other factors may be more influential in determining instructor activity levels.

Figure 5 shows the box plot for days since the last login, divided by course visibility. The box plot comparing instructor activity based on course visibility reveals that there is no significant difference in login behaviour between instructors of visible and hidden courses. In both categories, the median number of days since the last login is approximately 500, indicating that instructors, regardless of course visibility, tend to have similar patterns of inactivity. The interquartile range for both groups spans from around 250 to 1000 days, suggesting a wide variation in instructor engagement. Additionally, the presence of extreme values reaching up to 1750 days highlights that some courses' versions have been abandoned, perhaps new versions have been created. Overall, the data suggest that course visibility does not appear to influence instructor login frequency, and other factors may be more relevant in determining instructor engagement. It is likely that teachers who no longer use the course forget to hide it or intentionally leave it visible to students for continuous access to the materials. Some of those courses might be prepared during the pandemic period without training, preparation and experience from the teachers and without sufficient time to prepare all digital materials.

Further study aimed to explore temporal trends in the development of e-learning courses and the engagement of instructors over a multi-year period. The primary objective was to determine whether there have been statistically significant changes in the number of courses and instructor activity over time.

To conduct this analysis, the dataset was first grouped by the year in which each course was initiated. Two key indicators were selected for evaluation: the total number of courses launched each year and the number of instructors actively involved in course editing. These metrics were chosen as proxies for institutional investment in e-learning and the degree of academic staff participation.

The statistical method applied was linear regression, a standard technique in time series analysis used to identify trends and assess their significance. For each variable, a regression line was fitted to the annual data points, and the slope and p-value were calculated. The slope indicates the direction and magnitude of the trend, while the p-value tests the null hypothesis that there is no trend over time.

The results revealed a positive slope for both variables. The number of courses increased at an estimated rate of 23.08 courses per year, with a p-value of 0.0593. Instructor activity showed a similar upward trajectory, increasing by approximately 30.28 instructors per year, with a p-value of 0.0564. Although both p-values are slightly above the conventional threshold of 0.05, they suggest a marginally significant trend that warrants attention.

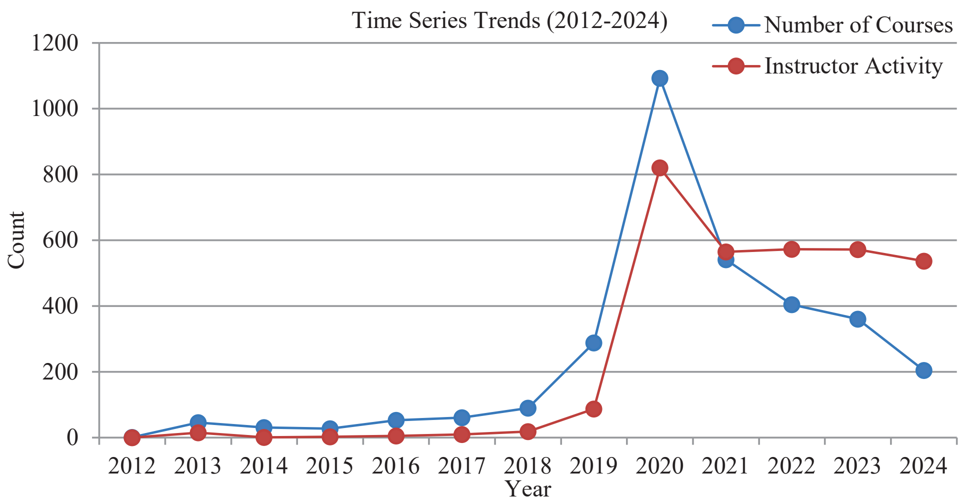

Figure 6. Trends in course creation and instructor enrollment (2012–2024)

These findings imply that the institution has experienced a gradual but consistent growth in its e-learning offerings and in the engagement of instructors in course development. While the statistical evidence is not strong enough to reject the null hypothesis with high confidence, the observed trends align with broader shifts in higher education toward digital learning environments, which confirms the H4 hypothesis.

In Figure 6, the trends in course creation and instructor engagement in the years 2012–2024 were presented. While the overall time series from 2012 to 2024 shows a gradual upward trend in both the number of courses and instructor activity, the year 2020 stands out as a clear anomaly. This spike is visibly distinct on the chart and corresponds with the onset of the COVID-19 pandemic, which forced educational institutions worldwide to rapidly transition to remote learning.

The data reveal a sharp increase in both course creation and instructor engagement during this period. This surge reflects the urgent institutional response to maintain academic continuity amid lockdowns and social distancing measures. Instructors who had not previously engaged with digital platforms were compelled to adapt quickly, resulting in a temporary but significant increase in online teaching activity.

This anomaly is not merely a statistical outlier – it represents a structural shift in how education was delivered. Although subsequent years show a slight normalisation, the post-2020 levels remain elevated compared to the pre-pandemic baseline, suggesting that some of the digital transformation initiated during the crisis has persisted.

From a strategic standpoint, this event underscores the importance of resilience and adaptability in educational systems. It also highlights the potential for crisis-driven innovation to accelerate long-term change. Institutions should consider how the lessons learned in 2020 can inform future investments in digital infrastructure, training, and pedagogical flexibility.

The implications of this analysis are twofold. First, the upward trends suggest that e-learning is becoming an increasingly integral part of the academic landscape. Second, the growing involvement of instructors indicates a positive institutional culture around digital pedagogy. However, the variability across years and disciplines also highlights the need for tailored e-learning strategies that reflect the specific needs and dynamics of different academic programs.

In conclusion, the analysis supports the hypothesis that meaningful changes have occurred over time in both course creation and instructor participation. These insights can inform strategic planning, resource allocation, and professional development initiatives aimed at sustaining and enhancing the quality of online education.

Discussion

We interpret the institutional Moodle activity in this study using four complementary theoretical models to move beyond technical reporting.

First, the Technological Pedagogical Content Knowledge (TPACK) and Substitution Augmentation Modification Redefinition (SAMR) frameworks explain differences in course design by describing the level of technology integration and pedagogical knowledge. For example, our results show that programmes such as Computer Science and Biomedical Engineering have larger digital footprints and more frequent updates, which correspond to higher SAMR stages (modification/redefinition) and stronger TPACK integration (Koehler & Mishra, 2009; Puentedura, 2012).

Second, the Technology Acceptance Model (TAM) and its extension, UTAUT2, help explain variations in instructor engagement. The Mann–Whitney test revealed no significant difference in instructor recency between hidden and visible courses, suggesting that perceived usefulness and workflow factors – rather than visibility settings – drive adoption, consistent with TAM/UTAUT2 predictions (Venkatesh et al., 2012).

Third, the European Digital Competence Framework for Educators (DigCompEdu) provides a competence-based view. The wide dispersion in instructor login recency and resource size across disciplines indicates uneven digital competences in areas such as assessment and learner engagement, echoing Aiastui et al.'s (2021) emphasis on differentiated professional development needs.

Fourth, the EDUCAUSE Digital Maturity Model (Dx) situates these patterns within institutional culture and governance. The sharp increase in course provisioning during 2020, followed by stabilisation, reflects a reactive digital transformation triggered by the COVID-19 pandemic rather than incremental growth-precisely the resilience and strategic pivot described in EDUCAUSE Dx guidance (Brooks and McCormack, 2020).

Together, these models allow a theory-driven interpretation of our findings: design maturity explains resource intensity, acceptance models clarify behavioural patterns, competence frameworks highlight skill gaps, and digital maturity accounts for structural shifts during disruption.

Conclusions

This study provided an analysis of e-learning course activity on the Moodle platform at the Faculty of Science and Technology, University of Silesia. By examining key indicators such as student enrollment, instructor login frequency, and the volume of uploaded teaching materials, the research revealed significant variability in course activity and resource intensity across different academic disciplines. While the dataset does not include detailed information about internal course structure or content editing history, the analysed variables serve as proxies for course usage and instructor involvement, which may reflect broader patterns of course management and engagement.

The findings indicate that while some courses are actively managed and attract large numbers of students, others show signs of neglect, including long periods of instructor inactivity and minimal content. The Kruskal–Wallis test confirmed that these differences are statistically significant and closely tied to the field of study. Interestingly, the analysis also showed that course visibility (whether a course is hidden or visible to students) does not significantly influence instructor engagement.

Furthermore, the time series analysis revealed a gradual upward trend in both course creation and instructor participation over the years, with a notable increase in 2020 due to the COVID-19 pandemic. Although the post-pandemic period saw a slight normalisation, the overall levels of digital engagement remained higher than before, indicating a lasting shift in educational practices. The pandemic-driven spike in 2020 illustrates how external shocks accelerate technology adoption, aligning with EDUCAUSE Dx's emphasis on resilience and strategic agility. This suggests that universities should not only prepare for crisis-driven transitions but also embed sustainable digital practices into long-term planning.

The observed disciplinary differences in course activity align with findings by Baran et al. (2021) and Hacıoğlu & Gülhan (2021), who noted varying pedagogical approaches across STEM and humanities fields. However, our data suggest even greater variability in instructor engagement and resource usage than previously reported. These disparities highlight the need for differentiated faculty development initiatives, as recommended by DigCompEdu, focusing on advanced digital competencies for some fields and foundational skills for others.

Our results show that many courses have not been updated for long periods, with some instructors inactive for over 1,200 days. Universities should set up automatic alerts and regular checks to keep courses current. Large differences in file sizes – some courses exceeding 2 GB while others have almost no materials – suggest the need for clear rules on resource use and archiving old files. Disciplines such as Informatics and Biomedical Engineering, which exhibit high activity and rich resources, can serve as examples for training programs. At the same time, fields with low engagement require additional support in creating interactive content. The sharp increase in 2020, during the pandemic, highlights the importance of planning for emergencies and maintaining strong digital practices after crises. Finally, using Moodle analytics to track enrollment, resource size, and instructor activity can help universities make better decisions about course design and support.

These insights underscore the importance of continuous monitoring and strategic planning in the development of e-learning environments. Institutions should consider implementing regular audits of course activity, providing targeted support for underperforming areas, and encouraging best practices in digital pedagogy. By doing so, universities can ensure that their online learning platforms remain effective, engaging, and aligned with the evolving needs of students and educators.

Data Availability Statement

The datasets generated during the current study are available from the corresponding author on reasonable request. None of the data or materials for the experiments reported here is available, and none of the experiments was preregistered.

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Małgorzata Przybyła-Kasperek, Jakub Sacewicz, Paweł Pawełczyk

Analiza aktywności kursów e-learningowych na platformie Moodle na Wydziale Nauk Ścisłych i Technicznych Uniwersytetu Śląskiego

Streszczenie

W artykule przedstawiono kompleksową analizę aktywności kursów e-learningowych prowadzonych na platformie Moodle na Wydziale Nauk Ścisłych i Technicznych Uniwersytetu Śląskiego. Głównym celem badania była ocena struktury, zaangażowania oraz wykorzystania zasobów cyfrowych w kursach online w różnych dyscyplinach akademickich. Zbiór danych, zebrany przed procesem archiwizacji platformy, obejmował takie zmienne jak liczba zapisanych studentów, częstotliwość logowania się prowadzących oraz rozmiar przesłanych materiałów dydaktycznych.

Do analizy różnic między kierunkami studiów oraz wpływu widoczności kursu na aktywność prowadzących zastosowano statystyki opisowe oraz testy nieparametryczne (Kruskal–Wallis, U Manna–Whitneya). Dodatkowo przeprowadzono analizę szeregów czasowych z wykorzystaniem regresji liniowej w celu identyfikacji trendów w tworzeniu kursów i zaangażowaniu prowadzących w latach 2012–2024.

Wyniki ujawniły istotne różnice w aktywności kursów między dyscyplinami – niektóre kierunki charakteryzowały się dużą liczbą studentów i intensywnym wykorzystaniem zasobów, podczas gdy inne wykazywały długotrwałą nieaktywność prowadzących. Wbrew oczekiwaniom, widoczność kursu nie miała istotnego wpływu na aktywność nauczycieli. Zaobserwowano pozytywny, choć marginalnie istotny trend wzrostu liczby kursów i zaangażowania prowadzących w czasie, ze szczególnym wzrostem w roku 2020 w związku z pandemią COVID-19.

Wnioski z badania podkreślają potrzebę wdrażania zróżnicowanych strategii zarządzania kursami cyfrowymi oraz wspierania działań instytucjonalnych na rzecz poprawy jakości i trwałości środowisk e-learningowych.

Słowa kluczowe: Moodle, e-learning, zaangażowanie prowadzących, analiza aktywności kursów, edukacja cyfrowa, szkolnictwo wyższe, statystyka nieparametryczna

Małgorzata Przybyła-Kasperek, Jakub Sacewicz, Paweł Pawełczyk

Análisis de la actividad de los cursos de aprendizaje en línea en la plataforma Moodle en la Facultad de Ciencias y Tecnología de la Universidad de Silesia

Resumen

Este estudio presenta un análisis integral de la actividad de los cursos de aprendizaje en línea impartidos a través de la plataforma Moodle en la Facultad de Ciencias y Tecnología de la Universidad de Silesia. El objetivo principal fue evaluar la estructura, el nivel de participación y el uso de recursos digitales en los cursos en línea en diversas disciplinas académicas. El conjunto de datos, recopilado antes del proceso de archivado de la plataforma, incluyó variables como el número de estudiantes inscritos, la frecuencia de inicio de sesión de los docentes y el tamaño de los materiales didácticos subidos.

Se utilizaron estadísticas descriptivas y pruebas no paramétricas (Kruskal–Wallis, U de Mann–Whitney) para evaluar las diferencias entre áreas de estudio y el impacto de la visibilidad del curso en la participación del profesorado. Además, se realizó un análisis de series temporales mediante regresión lineal para identificar tendencias en la creación de cursos y la participación docente entre 2012 y 2024.

Los resultados revelan disparidades significativas en la actividad de los cursos entre disciplinas: algunas muestran un alto número de estudiantes y uso intensivo de recursos, mientras que otras presentan una inactividad prolongada por parte del profesorado. Contrario a lo esperado, la visibilidad del curso no influyó significativamente en la participación docente. Se observó una tendencia positiva, aunque marginalmente significativa, tanto en el número de cursos como en la implicación del profesorado a lo largo del tiempo, con un aumento notable en 2020 debido a la pandemia de COVID-19.

Estos hallazgos subrayan la necesidad de estrategias adaptadas para la gestión de cursos digitales y respaldan los esfuerzos institucionales por mejorar la calidad y sostenibilidad de los entornos de aprendizaje en línea.

Palabras clave: Moodle, aprendizaje en línea, participación docente, análisis de actividad de cursos, educación digital, educación superior, estadística no paramétrica

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Анализ активности онлайн-курсов на платформе Moodle на факультете науки и технологий Силезского университета

Аннотация

В данной работе представлен всесторонний анализ активности онлайн-курсов, реализуемых на платформе Moodle на факультете науки и технологий Силезского университета. Основной целью исследования была оценка структуры, вовлеченности и использования цифровых ресурсов в онлайн-курсах по различным академическим направлениям. Набор данных, собранный до начала процесса архивирования платформы, включал такие переменные, как количество зарегистрированных студентов, частота входа преподавателей в систему и объем загруженных учебных материалов.

Для оценки различий между направлениями обучения и влияния видимости курса на активность преподавателей были использованы описательная статистика и непараметрические тесты (Краскела–Уоллиса, Манна–Уитни). Кроме того, был проведен анализ временных рядов с использованием линейной регрессии для выявления тенденций в создании курсов и участии преподавателей в период с 2012 по 2024 год.

Результаты показали значительные различия в активности курсов между дисциплинами: в некоторых направлениях наблюдалось большое количество студентов и интенсивное использование ресурсов, тогда как в других — длительная неактивность преподавателей. Вопреки ожиданиям, видимость курса не оказала существенного влияния на активность преподавателей. Была выявлена положительная, хотя и статистически незначительная тенденция увеличения количества курсов и вовлеченности преподавателей с течением времени, особенно заметная в 2020 году в связи с пандемией COVID-19.

Полученные данные подчеркивают необходимость разработки адаптированных стратегий управления цифровыми курсами и поддержки институциональных усилий по повышению качества и устойчивости онлайн-обучения.

Ключевые слова: Moodle, электронное обучение, активность преподавателей, анализ активности курсов, цифровое образование, высшее образование, непараметрическая статистика