

Educational Activities: Key Theoretical Concepts and Characteristics in the Digital Age

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ABSTRACT:

The aim of the study was to empirically define the features of students' educational activities in the digital age through the comparative analysis of three learning formats, traditional online, blended, and adaptive, and to test their influence on cognitive variables, motivational/emotional components, and digital competences. The study was implemented in the experimental format of a randomized comparative experiment with pre-/post measurements of indicators involving students of a Ukrainian university. The methodological basis was an integrative theoretical framework, which combines various paradigms (connectivist, cognitivist, humanistic, and constructivist) for the analysis of educational activities in a digital environment. Empirical data were collected using a standard battery of tests, questionnaires, digital analytics of learning platforms, and semi-structured interviews. Quantitative data were collected on cognitive achievement, motivation, social activity, digital competences, and a digital activity index; qualitative data were collected on students' subjective experience of learning in different environments. The results revealed that the adaptive format demonstrated higher learning results and a higher development of digital competences, while the blended format demonstrated a higher development of motivation and social components. Statistically significant correlations between digital activity and achievement and digital competences were identified. The practical value of the research can be implemented in the elaboration of flexible models of education, combining personalization of learning with its socialization.

Keywords: education, educational activities, teachers as subjects of educational activities, students as subjects of educational activities, digitization of education.

1. Introduction

The rapidly happening processes of digitalization and the worldwide socio-technological ones radically change modern education, turning it into a dynamic, flexible, and multidimensional system that demands constant updates of content and teaching techniques (Alenezi, 2021). The proliferation of digital technologies, the new trends in the development of computer and digital network communications, and intensified information flows all foster a shift of educational activity from a content transfer model to an activity-based, learner-centered, and technology-mediated approach (Akour & Alenezi, 2022; Mahlow & Hediger, 2019). The digital age not only broadens the number of various possibilities for personalized, flexible, and interactive education but also causes the problem of a number of structural imbalances that require theoretical rethinking (Hikmah et al., 2020; Timmis et al., 2016).

Global experience shows that the digital transformation of education has become a systemic necessity, especially after the COVID-19 pandemic, which accelerated the transition of universities to online and hybrid formats (Akour et al., 2021; Nurhas et al., 2022). European and global strategies emphasize the integration of technologies, the development of digital competencies, and the implementation of data analytics to improve the effectiveness of the educational process (Alenezi et al., 2023). At the same time, researchers emphasize that the digital environment is radically changing the roles of educational actors: teachers are becoming facilitators and moderators of educational interaction, and students are becoming active creators and co-authors of knowledge (Hopman et al., 2018; Tohara et al., 2021).

Along with opportunities, the digital age brings a bunch of challenges, with the main ones being unequal access to digital resources, different levels of digital literacy, information overload, and the risk of lower quality teaching (Danmuchikwali & Suleiman, 2020). Rapid technological and social changes require constant updating of teachers' professional competencies and adaptation of educational content to new formats and the needs of the digital economy (Hikmah et al., 2020). At the

same time, digitalisation activates the ethical dimension of educational activities related to copyright compliance, information security and the formation of responsible information behaviour (Tohara et al., 2021).

Despite significant scientific achievements, a number of aspects of educational activities in the digital environment remain underdeveloped. In particular, the theoretical boundaries of interaction between cognitive, humanistic, constructivist, and connectivist approaches that form the basis of modern digital learning need to be clarified (Ismail, 2024). Issues such as the balance between the technological component and socio-pedagogical interaction, ensuring digital equality, supporting inclusiveness, and forming sustainable educational practices in the context of rapidly changing technological paradigms also remain insufficiently understood (Tohara et al., 2021; Williams, 2015).

Thus, the modern digital era is radically changing the nature of educational activity, highlighting the need for systematic theoretical research into its concepts and specific functioning (Ismail, 2024). Awareness of these trends is a prerequisite for the formation of effective learning models capable of responding to the challenges and opportunities of a global digital society (Alenezi, 2021; Rapanta et al., 2020).

The transformation of educational activities in the digitalized environment calls for empirical research on the impact of various modes of learning organization (regular online learning, blended learning, digitalized computer-adaptive environments) on students' cognitive, motivational, and digital skills. The increasing influence of digital platforms intensifies the problem of merging connectivist, cognitivist, humanistic, and constructivist paradigms into real pedagogical practice, calling for comparative research on the effectiveness of digitalized learning formats. The aim of the study is to identify the characteristics of the impact of three digital learning formats on the motivational and emotional engagement, cognitive outcomes, and digital competencies of students, as well as to establish the relationships between digital activity in the learning environment and the increase in academic achievement. The scientific value of the

work lies in the formation of an integrative methodological framework for analyzing digital educational activities at the level of network interaction, collaborative activity, cognitive information processing, and motivational engagement. The practical significance of the research is determined by the possibility of using the results to optimize digital courses, improve blended learning models, and introduce adaptive platforms in higher education institutions.

2. Literature Review

Contemporary research underlines that the rapid development of digital environments has greatly affected the educational field and led to the transition to flexible and interactive networked forms of educational communication (Ismail, 2024). Scientific literature states that, according to connectivism, learning is the process of establishing relations between nodes of digital information, where knowledge is a network phenomenon (Budiyanto et al., 2024; Dacholfany et al., 2024). The educational process is seen as a dynamic combination of information connections in a digital environment (Ismail, 2024; Shvyryka, 2024).

Humanistic tendency highlights the necessity of self-development, emotional comfort, and learners' individual requirements, which are supported by learning using personalized technologies (Nasar et al., 2024; Shekhavtsova, 2019). Technology allows maximum learner freedom and provides additional means of learners' choice (Bai & Zhang, 2020). The cognitive approach explains learning as a process of cognizing, analyzing, systematizing, and storing information, realized in a digital environment with specialized programs (Broda et al., 2025; Ismail, 2024). Under this paradigm digital literacy is defined as the ability to cope with a large flow of data (Tabieh et al., 2021). Constructivist studies underline learning by experimentation, collective activities, and project work, which are represented in the use of digital tools and simulation environments (Gannar & Kilani, 2025; Jumaat et al., 2017; Matriano, 2020). The digital environment gives additional grounds for the use of simulation, task-based, and searching activities (Mhlongo et al., 2023).

The review of the literature presents the connections among learning theories, where constructivism is associated with connectivism on account of the social aspect of digital interaction and with cognitivism because deep information processing is required (Alam, 2024; Zahn, 2017). The humanistic orientation is also associated with network approaches, where student freedom is supported by digital tools (Philip, 2023; Shekhavtsova, 2016b). The global literature actively analyzes the impact of digital platforms and social networks, which increase student engagement and promote the development of collaborative learning (Akour & Alenezi, 2022; Santos et al., 2019; Sayaf et al., 2021). At the same time, it is emphasized that the success of e-learning depends on the convenience of digital interfaces and user experience (Alomari et al., 2020; Zardari et al., 2021). A significant body of publications focuses on the changing professional role of teachers, which involves the development of digital, organizational, and social competencies that are important for effective educational activities (Leonardi & Treem, 2020; Shekhavtsova, 2019). The need to develop digital skills is seen as a component of modern teacher training (Akour & Alenezi, 2022; Shekhavtsova, 2016b).

Social-emotional competencies are defined as an important outcome of education, encompassing intrapersonal and interpersonal skills necessary for successful activity in a digital context (Rout & Bhoi, 2024; Teeple & Benolken, 2023). In higher education, learning is interpreted as a transformative process that combines prior experience, problem-oriented approaches, and the development of metacognitive strategies (Alenezi et al., 2023). Social theories explain digital transformation as a factor in changing patterns of learning interaction and increasing student autonomy in a networked environment (Díaz-Noguera et al., 2022; Roth, 2019). Scientific discourse predicts the development of flexible models of higher education, in particular modular programs and blended learning, in line with digital trends (Cahyono et al., 2019; Osadcha et al., 2022).

Digital education is defined as an interactive, networked, and flexible environment that changes

the ways of accessing knowledge and organizing educational processes through Web 2.0 technologies, mobile applications, and cloud services (Greenhow et al., 2022). An important trend is the blurring of boundaries between formal and informal learning (Selwyn et al., 2023). Readiness for online learning is seen as a combination of digital competence, autonomy, motivation, and psychological readiness of students (Díaz-Noguera et al., 2022; Martín et al., 2020). Synchronous learning formats require a high level of communication confidence and technical training (Alenezi et al., 2023). The literature systematizes the role of information and communication technologies as a key component of modern education, providing access to resources, management of learning processes, and online assessment (Deroncele-Acosta et al., 2023; Nurhas et al., 2022). Different types of digital learning are discussed, such as adaptive systems, blended learning, and virtual learning environments (Alam & Mohanty, 2023; Shekhavtsova, 2016b). Research mentions key benefits of digital education, including flexibility, autonomy, and access, as well as some restrictions, especially digital inequality and the challenge of acquiring practical skills remotely (Imran & Almusharraf, 2024; Moraes et al., 2023).

Statement of objectives. In this regard, empirical knowledge on the impact of different types of digital learning on the nature and effectiveness of educational activities has been stimulated. Empirical data on the impact of different types of digital learning formats (e.g., conventional online courses, blended learning, adaptive systems), mechanisms of motivation development in digital learning environments, and the possibility to adapt the connectivist, cognitivist, humanist, and constructivist approaches in practice are somewhat limited. The objective of the research is to identify features of the impact of three types of digital learning on the effectiveness of students' learning, particularly academic engagement, learning performance, and digital skills development, and the interaction of those parameters with features of the student experience in a digital learning environment. To achieve this objective, a comparison of three models of learning should be made, a set of quantitative and qualitative indicators of learning

activity should be analyzed, and a system of interpreting students' perceptions of digital tools' effectiveness should be formulated.

Research objectives:

1. Determine the initial level of digital competencies, motivational engagement, and learning outcomes of participants before the experiment.
2. Compare the dynamics of student engagement, cognitive outcomes, and digital activity in three learning formats: traditional online learning, blended learning, and adaptive platform.
3. Analyze how the type of digital format affects the development of digital competencies and the ability to work with educational information.
4. Assess the relationships between students' digital activity, their engagement, and the increase in learning outcomes.
5. To summarize qualitative interpretations of student experiences using different digital learning formats based on thematic analysis of interviews.

Working hypotheses of the study

Hypothesis 1. Compared to conventional online methods, the use of adaptive platforms results in increased learning outcomes.

Hypothesis 2. Blended learning produces more motivational and socio-emotional engagement of students than the other formats.

Hypothesis 3. The level of digital activity on the learning platform is associated with digital skills and cognitive progress.

3. Materials and Methods

Methodological basis of the study

The methodological concept of the study is an integrative framework combining four key ideas of modern education in the digital age. It provides a coherent operationalization of central constructs, including digital skills, motivational and emotional engagement, and cognitive results. The primary principle is connectivism, presenting learning as the networked connection of digital knowledge nodes (Budiyanto et al., 2024), which makes it possible to

consider “digital interactions” and “network activity” indicators as a measure of engagement in the information exchange process. The cognitive paradigm considers learning as information processing, structuring, and transforming within an adaptive platform (Broda et al., 2025; Zahn, 2017) and sets a frame for analytical and theoretical kinds of thinking, as well as developing tasks for knowledge analysis, interpretation, and generalization. The humanistic approach recognizes the importance of student’s independence, emotional health, and self-control (Nasar et al., 2024; Shekhavtsova, 2019) as a factor that makes it possible to assess intrinsic motivation, cognitive ease, and comfort in the learning process.

Constructivism sees knowledge as an end product of active engagement in the material and social environment, which is implemented in collaborative activities and project-based formats (Novia et al., 2024), justifying the necessity to include indicators of one’s cooperation and joint problem discussion. The integration of the mentioned theoretical approaches creates the space for a complete assessment of the interaction of educational formats, digital skills, engagement, and learning achievement. To operationalize the measures transparently, a matrix of mappings between conceptual frameworks and empirical indicators was formulated (Table 1).

Table 1. Correspondence between theoretical approaches and research variables

Theory	Analytical level	Key variable	Instrument	Indicators
Connectivism	Macro level	Digital engagement	Questionnaire; digital analytics	Digital activity index; frequency of interaction
Constructivism	Meso level	Collaborative activity	Questionnaire; Moodle logs	Participation in discussions; project task completion
Cognitivism	Micro level	Cognitive outcomes	Standardized achievement test	Analysis; generalization; knowledge transfer
Humanism	Personal level	Motivational engagement	Questionnaire	Intrinsic motivation; autonomy; perceived comfort

Source: developed by the authors

Study design and sample

The study was done in the design of a randomized comparative experiment at a single Ukrainian regional university, which presents a potential limit on the overall generalization of the study. In the study there was a possibility to analyze a number of types of side effects, both the intragroup dynamics (T1, T2) and between-group differences, based on baseline levels of participants at the T1 stage. Students took one integrative course «Digital instruments for blended and adaptive learning» (3 ECTS credits, 90 hours, of which 24 were synchronized and the remaining were independent work on Moodle and an adaptive online system). The course covered topics of digital literacy, information strategies, adaptive system basics,

online co-operation, and instruction design. The instructor (with more than 10 years of experience in each of the directions) worked according to a standardized scenario and was uninformed about group affiliation.

Ninety second- and third-year students (58 women, 32 men) who were accustomed to working in a digital environment participated. Inclusion criteria: experience in online/blended learning, general digital literacy. Exclusion criteria: lack of permanent access, specialized preparation in information technology, and not filling in all points of the initial questionnaire. Prior to assignment, all potential participants completed a screening questionnaire designed to verify compliance with the inclusion and exclusion criteria (Appendix 1). The screening

instrument collected demographic data, previous experience in online and blended learning, self-assessed digital literacy, and technical readiness for participation. The participants were randomly assigned using a computer to three equal groups (CG, EG1, and EG2, 30 each), stratified by department and education year using stratified randomization. A pre-determined power analysis ($f = 0.25$, $\alpha = 0.05$, $1-\beta = 0.80$) yielded a minimum number of subjects to be included in the study equal to 84; actual $N = 90$. The control group studied using the standard Moodle/Zoom online format; EG1 used blended learning using asynchronous modules combined with face-to-face seminars once every two weeks; EG2 used an adaptive digital learning environment with automatic adjustment of the difficulty level of the subjects and tasks. The only independent variable was the format of instruction; the content, schedule, assessment criteria, and instructor remained consistent for all three groups. Adherence to the design was supervised by the monitoring of activity in Moodle and synchronous sessions in Zoom. The duration of the experiment was six weeks and included: initial testing of learning engagement indicators, digital abilities, and learning outcomes (T1); completing modules in three formats; final testing and questionnaires (T2); and online interviews with a randomly selected subsample of 15 students for maximally divergent selection. The groups used identical modules.

Methods of data collection and analysis

Data collection was carried out in a mixed format and included quantitative and qualitative methods. The main tool for quantitative measurement was a standardized online questionnaire developed based on theoretical approaches to digital literacy, online readiness, and student engagement (Erlam et al., 2021; Ismail, 2024). The questionnaire was in three parts: digital competencies, motivational and emotional engagement, and self-evaluation of information processing strategies. The answers were given based on a five-point Likert-type scale. The questionnaire was applied two times: before the beginning of the experiment and after the end of training modules (Appendix 2 and Appendix 3). The reliability of the scales was verified using Cronbach's alpha coefficient. Cronbach's alpha for all subscales exceeded 0.70. It established good reliability of the measurement instrument. Exploratory factor analysis (further – EFA) was used to check the structure of the original instrument. We used the principal component method with varimax rotation. The results of the EFA confirmed a structure of the instrument that consisted of three dimensions (digital competencies, motivational engagement, strategic regulation), accounting for 62.4% of the total variance. The KMO measure was 0.81 and Bartlett's test was statistically significant ($p < 0.001$). All factor loadings exceeded 0.50 (Table 2). The convergent validity was assessed through the average variance extracted ($AVE > 0.50$), and discriminant validity by a comparison between the AVE and the squared interfactor correlations.

Table 2. Factor loadings (only factor loadings ≥ 0.40 are shown)

Item	Factor 1	Factor 2	Factor 3
I1	0.74	0.18	0.11
I2	0.71	0.22	0.09
I3	0.68	0.25	0.14
I4	0.19	0.72	0.21
I5	0.16	0.69	0.24
I6	0.12	0.71	0.27
I7	0.11	0.20	0.76
I8	0.14	0.18	0.73
I9	0.17	0.23	0.69

Source: developed by the authors

A standardized test covering knowledge of the training modules and cognitive operations of analysis, generalization, and application of the material was used to measure learning outcomes (Appendix 4). The test consisted of 20 multiple-choice questions and four short open-ended questions. For T1 and T2, two content-equivalent test versions were used, the equivalence of which was verified by the average scores of the pilot group and the complexity of the tasks. Additionally, digital analytics data from three platforms were used: activity in Moodle, Zoom participation logs, and progress in the adaptive system. The number of logins, the duration of work with materials, the proportion of completed tasks, and participation in communicative activities were recorded, on the basis of which an integral index of digital activity was formed by standardizing and averaging z-scores. This reduced the influence of extreme values and ensured a stable assessment of students' digital behavior.

For qualitative analysis, semi-structured online interviews were conducted with 15 participants regarding their perception of learning formats, difficulties, changes in motivation, and assessment of their own digital competence. The interviews were conducted in Google Meet and recorded with the participants' permission. The transcripts were analyzed using thematic analysis with combined coding; reliability was ensured by double analysis and category agreement, and inter-expert agreement was calculated for the subsample.

Statistical data processing

Quantitative data were analyzed by means of IBM SPSS Statistics software (version 27). The first step of data processing involved an analysis of descriptive statistics (mean values, standard deviations, medians). Distribution normality was assessed by means of the Shapiro-Wilk test. As some of the indicators did not meet the assumption of normal distribution, nonparametric Wilcoxon and Mann-Whitney criteria were used. To analyze the three groups, the Kruskal-Wallis criteria were used. The effectiveness of the three formats of learning was evaluated based on the calculation of the effect η^2 and r . Correlation analysis of digital activity and level of students' engagement on the

one hand and student achievement on the other hand was performed by means of the Spearman coefficient. The level of statistical significance was set at $p < 0.05$. To control the risk of type I error in multiple comparisons, the Bonferroni correction was applied. The interpretation of effect sizes was carried out in accordance with Cohen's generally accepted guidelines. In addition to statistical significance, the interpretation of the results was based on effect sizes as indicators of practical significance, which is critically important in quasi-experimental educational studies with a moderate sample size. To increase the accuracy of interpretation, all effects are presented with 95% confidence intervals. Qualitative analysis of the interviews was performed in NVivo 14 using mixed deductive-inductive coding.

Methodological limitations of the study

The study has several limitations that could influence the interpretation of the results; some of them are the following: (a) a sample of students from only one university, which constrains the generalization of the results; (b) lack of control over individual learning and motivation; (c) the fact that some indicators are based on self-evaluation; (d) data on all types of learning behaviors in digital environments are not comprehensively registered; (e) the limited size of the sample for qualitative analysis, although it to some extent guarantees the variability of the data; (f) since all the students participate in the same educational system, study the same course, and learn with the same teacher, participants' responses may be rooted in the specifics of the particular educational system. The university features, curriculum design, digital culture of the university, and individual teaching style may have an impact on how deeply students immerse themselves into the suggested learning activities and the way they react to different formats of learning. The generalization of the results to other educational systems should be made with caution. Furthermore, the duration of the experiment (six weeks) does not allow for an evaluation of the long-term impact of learning formats; this question is a matter of further research.

Ethical issues of research

This research was carried out in accordance with the ethical principles of academic integrity and social sciences empirical research standards. All participants completed their participation of their own will, after being fully informed about the general aims, protocols, and requirements of the study. Prior to any data collection, all participants signed an email-generated consent form posted on the university's own internal system. All data were kept anonymous: no personal data were collected and all results were ranked anonymously. Interview recordings were made only with the prior permission of the participants. All electronic records were stored in password-protected files accessible only by the researcher. There were no risks or potential negative effects for students at any stage, and students were free to withdraw from the study at any point without giving reasons.

4. Results

Analysis of the pre-experiment data (T1) found no statistically significant differences between all three groups on all key indicators. The average level of

digital competencies in the control group was $M = 3.42$ ($SD = 0.45$); in the blended learning group, $M = 3.40$ ($SD = 0.43$), and in the adaptive learning group, $M = 3.41$ ($SD = 0.44$). The same was true for the motivational engagement level ($M = 3.56, 3.60$) and for the average test score (60.9, 61.7%). The Kruskal–Wallis criterion demonstrated no differences between groups (H between 0.84 and 1.27; p between .53 and .66), thus establishing the comparability of all studied samples at the beginning of the experiment. After training in T2 (training modules completion), there was a definitive differentiation of formats in the productive indicators of cognitive performance. The test score in the adaptive learning group increased from $M = 60.9$ ($SD = 8.4$) to $M = 74.6$ ($SD = 7.9$), in the mixed group, from $M = 61.7$ ($SD = 8.9$) to $M = 70.2$ ($SD = 8.1$), and in the control group, from $M = 61.3$ ($SD = 8.6$) to $M = 66.1$ ($SD = 8.3$). Wilcoxon's criterion detected a statistically significant growth of the test score in all groups ($p < 0.01$). Concurrently, intergroup differences ($H = 12.84$; $p < 0.01$; $\eta^2 = .18$) were statistically significant, with the adaptive group demonstrating the highest average scores (Figure 1).

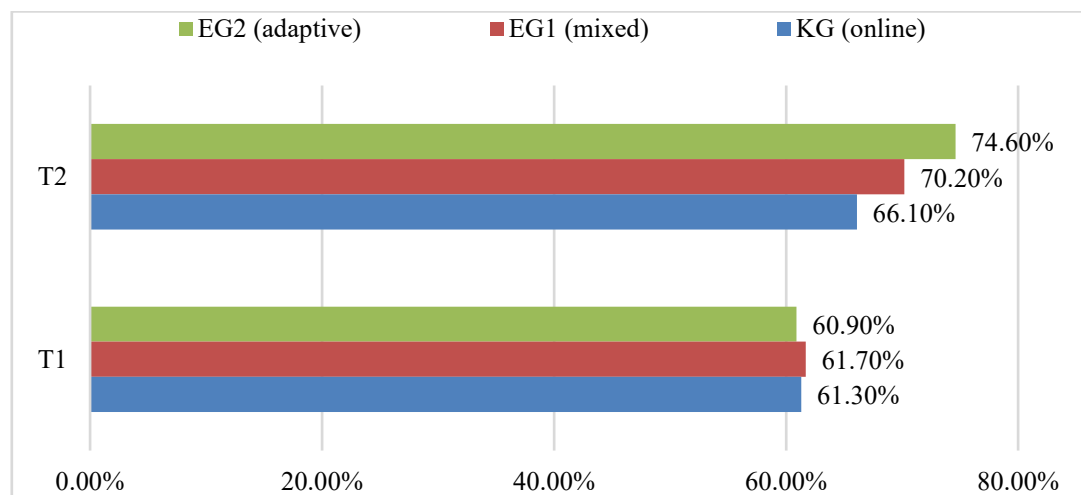


Figure 1. Dynamics of cognitive results (T1–T2) in three learning formats

Source: developed by the authors

The assessment of motivational and emotional engagement showed a different configuration of results. The largest increase was recorded in the blended learning group: $M(T1) = 3.56$ ($SD = 0.45$) $\rightarrow M(T2) = 4.02$ ($SD = 0.41$). In the adaptive group,

the indicator increased to $M = 3.91$ ($SD = 0.39$), and in the control group, to $M = 3.72$ ($SD = 0.44$). The difference between the groups at the final stage is statistically significant ($H = 9.73$; $p < 0.01$), with an advantage for the blended format (Figure 2).

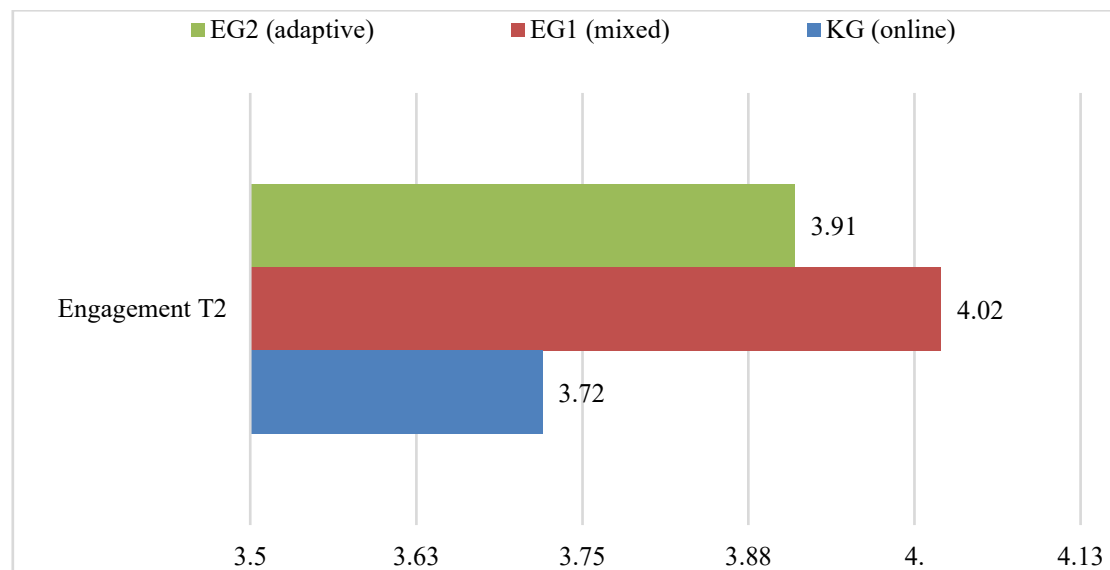


Figure 2. Average indicators of students' motivational engagement in three groups (T2)

Source: developed by the authors

The analysis of digital competencies showed the greatest increase in the adaptive learning group ($\Delta M = +0.48$), where the average value at T2 was $M = 3.96$ ($SD = 0.38$). In the mixed group, the indicator was $M = 3.81$ ($SD = 0.41$), and in the control group, it was $M = 3.62$ ($SD = 0.43$). The intergroup differences are statistically significant ($H = 10.19$; $p < 0.01$), indicating the higher effectiveness of the adaptive environment in terms of digital skills development.

The digital activity index, formed on the basis of platform logs, was highest in the adaptive learning group ($M = 0.42$; $SD = 0.55$), average in the mixed group ($M = 0.11$; $SD = 0.58$), and lowest in the

control group ($M = -0.53$; $SD = 0.61$). The difference between the groups is statistically significant ($H = 14.26$; $p < 0.001$). Correlations between the main variables examined with Spearman's correlation indicated statistically significant associations. The digital activity index showed positive associations with gains in cognitive performance ($r = .46$; $p < .001$) and digital competence levels ($r = .51$; $p < .001$). Motivational engagement was weakly positively correlated with performance ($r = .39$; $p < .01$), which indicates the stabilization of the dynamics of behavioral, personal, and educational activity performance parameters. The aggregated quantitative indicators of the main variables are given in Table 3.

Table 3. Generalized quantitative indicators in three groups at stage T2

Indicator	CG (online) M (SD)	EG1 (mixed) M (SD)	EG2 (adaptive) M (SD)	p
Cognitive results, %	66.1 (8.3)	70.2 (8.1)	74.6 (7.9)	< 0.01
Motivational engagement	3.72 (0.44)	4.02 (0.41)	3.91 (0.39)	< 0.01
Digital competencies	3.62 (0.43)	3.81 (0.41)	3.96 (0.38)	< 0.01
Digital activity index (z)	-0.53 (0.61)	0.11 (0.58)	0.42 (0.55)	< 0.001

Source: developed by the authors

Thematic analysis of semi-structured interviews allowed us to identify several consistent thematic clusters. Students in the adaptive group most often described learning as personalized and "moving along with my level," emphasizing the gradual increase in task complexity. Participants in the

blended format emphasized the importance of face-to-face seminars for maintaining motivation and a sense of belonging to the academic community. Representatives of traditional online learning more often mentioned difficulties with concentration and fragmented interaction. A summary of quantitative

and qualitative data showed that the adaptive format provides the greatest increase in cognitive outcomes and digital competencies, while blended learning is associated with higher student motivation and social-emotional engagement.

5. Discussion

The results obtained allow us to interpret educational activity in the digital age as a multidimensional process in which the format of learning organization acts as a system-forming factor in the development of cognitive, motivational, and digital parameters of student activity. The data obtained confirm the working hypotheses put forward and allow us to specify the mechanisms of influence of different learning formats on educational activity. The higher increase in cognitive results and digital competencies in the adaptive learning group is consistent with the provisions of cognitive theory, according to which learning is viewed as a process of active processing and structuring of information (Broda et al., 2025; Ismail, 2024). An adaptive system that automatically adjusts the complexity of tasks and the pace of material processing creates conditions for optimal cognitive load and individualization of the educational trajectory, which explains the observed effect. These results correlate with studies on the effectiveness of adaptive technologies and confirm the thesis of the pedagogical expediency of algorithmic personalization of content while maintaining the content integrity of the course (Kerr, 2016; Nwachukwu et al., 2025).

The dominance of the blended format in terms of motivational and emotional engagement corresponds to the humanistic logic of the student-centered approach (Nasar et al., 2024; Philip, 2023). The combination of online modules with regular face-to-face seminars creates conditions for maintaining social presence, dialogue, and subject-subject interaction, which is considered a key mechanism for the formation of student subjectivity (Shekhavtsova, 2014b). The results obtained are consistent with the conclusions about the higher effectiveness of blended learning compared to exclusively distance formats and confirm that the socio-emotional component of educational activity is enhanced by regular interpersonal interaction

(Dziuban et al., 2018; Ismail, 2024). The positive correlation between digital activity, cognitive gains, and digital competence levels confirms the connectivism principle of learning as a process of establishing and maintaining connections in a network (Budiyanto et al., 2024; Dacholfany et al., 2024). Activity in the digital environment is not only a behavioral indicator of participation but also a marker of inclusion in network interaction, which contributes to the expansion of the individual's "knowledge network." Thus, digital activity can be viewed as an operationalized manifestation of connectivist learning logic.

At the same time, the results of qualitative analysis of interviews suggest that the effectiveness of digital formats is mediated not only by technological characteristics, but also by the culture of feedback and the level of self-reflection among students. This is consistent with the provisions on the importance of feedback literacy and the role of feedback as a mechanism of self-regulation (Butenko, 2024; Carless & Winstone, 2023). The data obtained also confirm the concept of forming a student as an active subject of educational activity. The growth in indicators of independence, digital activity, and awareness of learning strategies correlates with the stages of subjectivity formation outlined in the works (Shekhavtsova, 2014a; Shekhavtsova, 2016a).

In summary, all three hypotheses are confirmed: the adaptive format proved to be the most effective for cognitive gains; blended learning – for increasing motivational engagement; digital activity demonstrated a statistically significant relationship with learning outcomes and digital competencies. The data obtained are consistent with the integrative theoretical framework and confirm the complementary nature of its approaches. At the same time, the results should be interpreted taking into account the limitations of the sample and the duration of the experiment. Further research should focus on longitudinal and inter-institutional analysis. In practice, the results can be used to design flexible education models that combine adaptive technologies and blended formats to develop autonomous and competent educational actors.

6. Conclusions

The results obtained validate the assertion that the learning organization format is of crucial importance to the transformation of students' educational activities in the digital age. An intercomparison provided evidence that the adaptive digital environment maximized the cognitive results and digital competencies, which indicates the efficiency of the algorithmic characterization of the content of education. Simultaneously, the blended format determined the higher standing of motivational and emotional components of the subjectivity of students. Based on the correlation analysis, the statistically significant relationship between digital activity, academic success, and digital competencies levels was proved, enabling digital activity to be considered an indicator of inclusion in the educational process. The convergence of quantitative and qualitative findings proves the

viability of the integrative approach, combining cognitive, personal, and network components of educational activity.

The novelty of the study lies in the empirical comparison of three digital learning formats within a single theoretical framework, taking into account both performance and behavioral-motivational indicators. The practical significance of the results lies in substantiating the expediency of combining adaptive technologies with socially rich blended formats to ensure a balance between cognitive efficiency and motivational support for students. At the same time, the interpretation of the results is limited by the institutional specificity of the sample and the duration of the experiment. Further research should focus on expanding the sample, inter-institutional comparisons, and analyzing the long-term effects of digital formats in different educational contexts.

References

- Akour, M., & Alenezi, M. (2022). Higher education future in the era of digital transformation. *Education Sciences*, 12(11), 784. <https://doi.org/10.3390/educsci12110784>
- Akour, M., Alenezi, M., Sghaier, H. A., & Shboul, Y. A. (2021). The COVID-19 pandemic: When e-learning becomes mandatory not complementary. *International Journal of Technology Enhanced Learning*, 13(4), 429–439. <https://doi.org/10.1504/IJTEL.2021.118003>
- Alam, A., & Mohanty, A. (2023). Evaluation of software engineering virtual laboratory in determining undergraduate students' conceptual understanding: A blended learning model using collaborative-creative virtual learning environment employing critical pedagogy. In *Sentiment Analysis and Deep Learning: Proceedings of ICSADL 2022* (pp. 875-899). Singapore: Springer Nature Singapore. https://doi.org/10.1007/978-981-19-5443-6_65
- Alam, M. A. (2024). Connectivism and Traditional Learning Theories: Implications for Contemporary Educational and Pedagogical Practices. *Bhartiyam international journal of education & research*, 14, 1–24. <https://doi.org/10.13140/RG.2.2.20807.82081>
- Alenezi, M. (2021). Deep dive into digital transformation in higher education institutions. *Education Sciences*, 11(12), 770. <https://doi.org/10.3390/educsci11120770>
- Alenezi, M., Wardat, S., & Akour, M. (2023). The need of integrating digital education in higher education: Challenges and opportunities. *Sustainability*, 15(6), 4782. <https://doi.org/10.3390/su15064782>
- Alomari, H. W., Ramasamy, V., Kiper, J. D., & Potvin, G. (2020). A User Interface (UI) and User eXperience (UX) evaluation framework for cyberlearning environments in computer science and software engineering education. *Heliyon*, 6(5). <https://doi.org/10.1016/j.heliyon.2020.e03917>
- Bai, H., & Zhang, Q. (2020). WITHDRAWN: English smart classroom teaching system based on 5G network and internet of things. *Microprocessors and Microsystems*. <https://doi.org/10.1016/j.micpro.2020.103421>
- Broda, M., Kovalova, K., Bezugla, I., Stoika, O., & Mulyk, K. (2025). Enhancing foreign language acquisition: innovative cognitive strategies and tools. *Conhecimento & Diversidade*, 17(45), 166–182. <https://doi.org/10.18316/rcd.v17i45.12371>

- Budiyanto, K. K., Harapan, E., Purwanto, M. B., & Smaratungga, S. T. I. A. B. (2024). 21st century English learning: A revolution in skills, critical thinking, creativity, and visual communication. *Asian Journal of Applied Education (AJAE)*, 3(1), 43–54. <https://doi.org/10.55927/ajae.v3i1.7841>
- Butenko, L. L. (2024) The phenomenon of feedback in the educational process of a higher education institution: explicit and implicit contexts. *Education and Pedagogical Science*, 2(186), 24–37. [https://doi.org/10.12958/2227-2747-2024-2\(186\)-24-37](https://doi.org/10.12958/2227-2747-2024-2(186)-24-37)
- Cahyono, A. N., Zaenuri, & Subagja, M. (2019). The design of blended learning modules for higher education. In *Journal of Physics: Conference Series* (Vol. 1387, No. 1, p. 012121). IOP Publishing. <https://doi.org/10.1088/1742-6596/1387/1/012121>
- Carless, D., & Winstone, N. (2023). Teacher feedback literacy and its interplay with student feedback literacy. *Teaching in higher education*, 28(1), 150–163. <https://doi.org/10.1080/13562517.2020.1782372>
- Dacholfany, M. I., Iqbal, M., Rahmi, E., & Purwanto, M. B. (2024). Principal's Leadership Strategy in Efforts to Development the Quality of Human Resources in Schools. *JlIP-Jurnal Ilmiah Ilmu Pendidikan*, 7(1), 487–493. <https://doi.org/10.54371/jlrip.v7i1.3356>
- Danmuchikwali, B. G., & Suleiman, M. M. (2020). Digital education: Opportunities, threats, and challenges. *Jurnal Evaluasi Pendidikan*, 11(2), 78–83. <https://doi.org/10.21009/10.21009/JEP.0126>
- Deroncele-Acosta, A., Palacios-Núñez, M. L., & Toribio-López, A. (2023). Digital transformation and technological innovation on higher education post-COVID-19. *Sustainability*, 15(3), 2466. <https://doi.org/10.3390/su15032466>
- Díaz-Noguera, M. D., Hervás-Gómez, C., De la Calle-Cabrera, A. M., & López-Meneses, E. (2022). Autonomy, motivation, and digital pedagogy are key factors in the perceptions of Spanish higher-education students toward online learning during the COVID-19 pandemic. *International Journal of Environmental Research and Public Health*, 19(2), 654. <https://doi.org/10.3390/ijerph19020654>
- Dziuban, C., Graham, C. R., Moskal, P. D., Norberg, A., & Sicilia, N. (2018). Blended learning: the new normal and emerging technologies. *International journal of educational technology in Higher education*, 15(1), 3. <https://doi.org/10.1186/s41239-017-0087-5>
- Erlam, R., Philp, J., & Feick, D. (2021). Digital Media in the Language Classroom. *Teaching Languages to Adolescent Learners*, 135–157. <https://doi.org/10.1017/9781108869812.008>
- Gannar, S., & Kilani, C. (2025). Contextualized Learning and Social Constructivism: Implementing a Project-Based Approach in Information Systems Development Education. *Journal of Science Learning*, 8(1), 15–24. <https://eric.ed.gov/?id=EJ1468663>
- Greenhow, C., Graham, C. R., & Koehler, M. J. (2022). Foundations of online learning: Challenges and opportunities. *Educational Psychologist*, 57(3), 131–147. <https://doi.org/10.1080/00461520.2022.2090364>
- Hikmah, K., Amrullah, M., Chotimah, C., & Alfariis, M. S. (2020). Evaluation of the Integrative Holistic-Based Al-Islam Kemuhammadiyah and Arabic Language (ISMUBA) Curriculum at SMA Muhammadiyah Sidoarjo. *Halaqa: Islamic Education Journal*, 4(2), 97–111. <https://doi.org/10.21070/halaqa.v4i2.985>
- Hopman, J. A., Tick, N. T., van der Ende, J., Wubbels, T., Verhulst, F. C., Maras, A., ... & Van Lier, P. A. (2018). Special education teachers' relationships with students and self-efficacy moderate associations between classroom-level disruptive behaviors and emotional exhaustion. *Teaching and Teacher Education*, 75, 21–30. <https://doi.org/10.1016/j.tate.2018.06.004>
- Imran, M., & Almusharraf, N. (2024). Digital Learning Demand and Applicability of Quality 4.0 for Future Education: A Systematic Review. *International Journal of Engineering Pedagogy*, 14(4). <https://doi.org/10.3991/ijep.v14i4.48847>
- Ismail, I. (2024). Exploring modern educational theories: A literature review of student learning in the digital age. *International Journal Multidisciplinary Science*, 3(3), 83–94. <https://doi.org/10.56127/ijml.v3i3.1646>
- Jumaat, N. F., Tasir, Z., Halim, N. D. A., & Ashari, Z. M. (2017). Project-based learning from constructivism point of view. *Advanced Science Letters*, 23(8), 7904–7906. <https://doi.org/10.1166/asl.2017.9605>
- Kerr, P. (2016). Adaptive learning. *ELT journal*, 70(1), 88–93. <https://doi.org/10.1093/elt/ccv055>

- Leonardi, P. M., & Treem, J. W. (2020). Behavioral visibility: A new paradigm for organization studies in the age of digitization, digitalization, and datafication. *Organization studies*, 41(12), 1601–1625. <https://doi.org/10.1177/0170840620970728>
- Mahlow, C., & Hediger, A. (2019). Digital transformation in higher education-buzzword or opportunity? *eLearn*, 2019(5), 13. <https://doi.org/10.1145/3329488/3331171>
- Martin, F., Stamper, B., & Flowers, C. (2020). Examining student perception of readiness for online learning: Importance and confidence. *Online Learning*, 24(2), 38–58. <https://eric.ed.gov/?id=EJ1260328>
- Matriano, E. A. (2020). Ensuring Student-Centered, Constructivist and Project-Based Experiential Learning Applying the Exploration, Research, Interaction and Creation (ERIC) Learning Model. *International Online Journal of Education and Teaching*, 7(1), 214–227. <https://eric.ed.gov/?id=EJ1244245>
- Mhlongo, S., Mbatha, K., Ramatsetse, B., & Dlamini, R. (2023). Challenges, opportunities, and prospects of adopting and using smart digital technologies in learning environments: An iterative review. *Heliyon*, 9(6). <https://doi.org/10.1016/j.heliyon.2023.e16348>
- Moraes, E. B., Kipper, L. M., Hackenhaar Kellermann, A. C., Austria, L., Leivas, P., Moraes, J. A. R., & Witczak, M. (2023). Integration of Industry 4.0 technologies with Education 4.0: advantages for improvements in learning. *Interactive Technology and Smart Education*, 20(2), 271–287. <https://doi.org/10.1108/ITSE-11-2021-0201>
- Nasar, I., Nurdianingsih, F., Rahmi, E., & Purwanto, M. B. (2024). Values of character education: Study of strengthening the culture of digital literacy for youth in disruptive 5.0 era. *Gema Wiralodra*, 15(1), 596–604. <https://doi.org/10.31943/gw.v15i1.688>
- Novia, F., Nurdianti, D., & Purwanto, M. B. (2024). English learning and innovation skills in 21st: Implementation of critical thinking, creativity, communication, and collaboration. *Asian Journal of Applied Education (AJAE)*, 3(2), 113–124. <https://doi.org/10.55927/ajae.v3i2.8318>
- Nurhas, I., Aditya, B. R., Jacob, D. W., & Pawlowski, J. M. (2022). Understanding the challenges of rapid digital transformation: the case of COVID-19 pandemic in higher education. *Behaviour & Information Technology*, 41(13), 2924–2940. <https://doi.org/10.1080/0144929X.2021.1962977>
- Nwachukwu, E. L., Egbue, N. G., & Victor-Nwakaku, I. (2025). Adaptive Learning Systems: Bridging Instructional Technology and Personalized Pedagogy through Design Thinking. *Journal of Digital Learning and Distance Education*, 4(5), 1689–1703. <https://doi.org/10.56778/jdlde.v4i5.588>
- Osadcha, K. P., Osadchyi, V. V., Spirin, O., Krasheninnik, I., & Horbatiuk, R. (2022). Model of blended learning in higher educational institutions: development, implementation and evaluation. *Information Technologies and Learning Tools*, 5(91), 158–169. <https://lib.iitta.gov.ua/id/eprint/732276>
- Philip, A. (2023). Educating Generation Z: Adapting Humanistic Teaching in Blended Learning Environment. In *International Conference on Advancing and Redesigning Education* (pp. 499-510). Singapore: Springer Nature Singapore. https://doi.org/10.1007/978-981-97-4507-4_54
- Rapanta, C., Botturi, L., Goodyear, P., Guàrdia, L., & Koole, M. (2020). Online university teaching during and after the Covid-19 crisis: Refocusing teacher presence and learning activity. *Postdigital science and education*, 2(3), 923–945. <https://doi.org/10.1007/s42438-020-00155-y>
- Roth, S. (2019). Digital transformation of social theory. A research update. *Technological Forecasting and Social Change*, 146, 88–93. <https://doi.org/10.1016/j.techfore.2019.05.016>
- Rout, B., & Bhoi, M. T. (2024). SEL and Technology: The Role of Digital Tools in Promoting Emotional and Social Skills. *International Journal for Research in Applied Science and Engineering Technology*, 12(12), 1584–1512. <https://doi.org/10.22214/ijraset.2024.66086>
- Santos, H., Batista, J., & Marques, R. P. (2019). Digital transformation in higher education: the use of communication technologies by students. *Procedia Computer Science*, 164, 123–130. <https://doi.org/10.1016/j.procs.2019.12.163>
- Sayaf, A. M., Alamri, M. M., Alqahtani, M. A., & Al-Rahmi, W. M. (2021). Information and communications technology used in higher education: An empirical study on digital learning as sustainability. *Sustainability*, 13(13), 7074. <https://doi.org/10.3390/su13137074>

- Selwyn, N., Hillman, T., Bergviken Rensfeldt, A., & Perrotta, C. (2023). Digital technologies and the automation of education—key questions and concerns. *Postdigital Science and Education*, 5(1), 15–24. <https://doi.org/10.1007/s42438-021-00263-3>
- Shekhavtsova, S. O. (2014a). The peculiarities of students' stimulation for obtaining subjective experience during the pedagogical practice. *Science and Education*, (7), 191–194. <http://dspace.pdpu.edu.ua/handle/123456789/6421>
- Shekhavtsova, S. O. (2014b). Subject-subject pedagogical interaction as a mechanism for forming student subjectivity towards professional and pedagogical activity. *Youth and Market*, (9), 50–54. http://nbuv.gov.ua/UJRN/Mir_2014_9_13
- Shekhavtsova, S. (2016). The structure of future teachers' subjectivities in the system of their personal qualities. In *Social and economic priorities in the context of sustainable development* (pp. 416–422). Opole: The Academy of Management and Administration in Opole. <https://dspace.luguniv.edu.ua/xmlui/handle/123456789/2801>
- Shekhavtsova, S. O. (2016b). Subjectivity in the pedagogical aspect: theory and practice. Poltava: VNZ Ukoopsilky "Poltavskyi universytet ekonomiky i torhivli" (PUET). <https://dspace.luguniv.edu.ua/xmlui/bitstream/handle/123456789/2782/2016.pdf?sequence=1&isAllowed=y>
- Shekhavtsova, S. O. (2019). Organization of distance subject-subject interaction in the course of future english philologists training. *Information Technologies and Learning Tools*, 71(3), 236–247. <https://doi.org/10.33407/itlt.v71i3.2459>
- Shvyrka, V. M. (2024). Gamification in the educational process of a higher education institution: a theoretical aspect. *Education and pedagogical sciences*, 3(187), 86–96. [https://doi.org/10.12958/2227-2747-2024-3\(187\)-86-96](https://doi.org/10.12958/2227-2747-2024-3(187)-86-96)
- Tabieh, A. A., Hamzeh, M., Abu-Foudeh, B. K. S., Jarrar, N., Al-Manaseer, S., Al-Shawabkeh, A., & Seikaly, R. (2021). Digital literacy and its acquisition by teachers and principals at educational workplaces. *International Journal of Learning, Teaching and Educational Research*, 20(5), 38–55. <https://doi.org/10.26803/ijlter.20.5.3>
- Teeple, S. K., & Benolken, A. (2023). Exploring the relationship between social-emotional competencies and student performance in online learning environments. *E-Learning and Digital Media*, 20(5), 460–472. <https://doi.org/10.1177/20427530221117328>
- Timmis, S., Broadfoot, P., Sutherland, R., & Oldfield, A. (2016). Rethinking assessment in a digital age: Opportunities, challenges and risks. *British Educational Research Journal*, 42(3), 454–476. <https://doi.org/10.1002/berj.3215>
- Tohara, A. J. T., Shuhidan, S. M., Bahry, F. D. S., & Nordin, M. N. B. (2021). Exploring digital literacy strategies for students with special educational needs in the digital age. *Turkish Journal of Computer and Mathematics Education*, 12(9), 3345–3358. <https://doi.org/10.17762/turcomat.v12i9.5741>
- Williams, P. (2015). Exploring the challenges of developing digital literacy in the context of special educational needs communities. *Innovation in Teaching and Learning in Information and Computer Sciences*, 5(1), 1–16. <https://doi.org/10.11120/ital.2006.05010006>
- Zahn, C. (2017). Digital design and learning: Cognitive-constructivist perspectives. In *The psychology of digital learning: Constructing, exchanging, and acquiring knowledge with digital media* (pp. 147–170). Cham: Springer International Publishing. https://doi.org/10.1007/978-3-319-49077-9_8
- Zardari, B. A., Hussain, Z., Arain, A. A., Rizvi, W. H., & Vighio, M. S. (2021). Development and validation of user experience-based e-learning acceptance model for sustainable higher education. *Sustainability*, 13(11), 6201. <https://doi.org/10.3390/su13116201>