International Journal of Education and Development using Information and Communication Technology (IJEDICT), 2024, Vol. 20, Issue 3, pp. 97-114

The benefits and barriers of open platforms to promote teaching and learning in Tanzania's higher learning institutions

Kwame Ibwe & Fatuma Ikuja
University of Dar es Salaam, Tanzania

ABSTRACT

This paper explores the benefits and barriers of open platforms in promoting university teaching and learning in Tanzania. Despite the potentials open platforms have in supporting teaching and learning processes in higher learning institutions, there is a continuing debate on their benefits and barriers. This study, therefore, examined staff and students experience on the use of open platforms and technologies in teaching and learning activities in four Tanzanian universities. A mixed approach (quantitative and qualitative) was employed for the study. A cross-sectional survey was used to collect data from a sample of 400 respondents selected through simple random sampling and from 15 purposively selected informants. The study findings suggest that faculty members and students use open platforms for academic discussions, posting and accessing lecture slides and tutorials, sharing materials and scholarly communication. On the basis of these findings, ICT infrastructure investment, training to upgrade skills and knowledge and policies are recommended to be in place to promote the usage of open platforms in teaching and learning. The findings highlight that while open platforms offer significant advantages in accessibility, collaboration, and resource availability, obstacles such as inadequate infrastructure and limited digital literacy hinder their widespread adoption.

Keywords: *open platform; information systems; teaching; learning; higher learning institution*

INTRODUCTION

The integration of open platforms in higher education is revolutionizing teaching and learning by providing greater access to resources and fostering collaborative environments (Ramirez-Montoya et al., 2024). Open platforms are the building blocks in the development of Education 4.0, a technique of learning that is connected with the fourth industrial revolution and focuses on transforming the future of education through advanced technology and automation (Chakraborty et al., 2023). This paper explores the benefits and barriers of open platforms in enhancing education in higher learning institutions in Tanzania. Tanzania is chosen as a case study due to its efforts in leveraging technology for educational improvement and the presence of several initiatives aimed at integrating open platforms in academia (Pholld Mwakyusa & Masome Ng`webeya, 2022). Numerous studies indicate that there has been a growing trend of integrating open educational platforms in higher education to expand access to learning, collaboration, adaptability and fulfilment of technological expectations of students and faculty members (Bitakou et al., 2023; Mwantimwa & Elia, 2019; Vlasenko et al., 2023; Wever et al., 2023). Evidently, open educational software development and collaboration, open-source software, open data and information, Internet of Things, and open cloud platforms have been adopted and integrated to foster teaching and learning activities in universities and colleges (Al Ghatrifi et al., 2023; Ghashim & Arshad, 2023; Klochko & Sharyhin, 2023; Yamamoto et al., 2019).

Open educational platforms like Moodle, Open edX, Sakai and Canvas Learning Management System are widely used in higher learning institutions to create and manage courses online as well as support research and collaboration (Egorov et al., 2021; Liapis et al., 2023; Pratama et al., 2023; Talib et al., 2019). The open education platforms can also be used to facilitate inclusive education and consequently meet Goal number four on Quality Education of the Sustainable Development Goals of the United Nations 2030 Agenda (Haleem et al., 2022).

The software development and collaboration platforms like GitHub, GitLab Bitbucket and Apache OpenOffice, provide tools and environments that facilitate interactive learning, collaboration, and practical skills development. These developments have revolutionized the way students learn and master important skills in the modern world (Eremeev et al., 2022; Miloradović & Milovanović, 2022; Tarigan et al., 2019). In addition, studies have documented the increase in the use of open-source software platforms such as Linux, LibreOffice, Apache OpenOffice, Graphical Design and Image Editing, GNU Image Manipulation Program(GIMP) and Firefox to promote teaching and learning in higher learning institutions (Afi Normawati, 2021; Al Ghatrifi et al., 2023; Fedosov & Markushevich, 2021; Flatscher, 2023). These platforms are typically free to use, which helps institutions save on licensing fees and reduces the financial burden on students. Open-source software can be modified to meet specific educational needs, allowing institutions to create customized teaching and learning environments (Chen et al., 2022). Several studies have discussed the use of open data and information platforms such as Wikipedia and OpenStreetMap for students and instructors to have access to vast amounts of information on a wide range of topics, making them valuable resources for conducting research (Azzam, 2017; Neri, 2023; Pereira et al., 2022. In particular, (Neri, 2023) discloses that OpenStreetMap can be used as a plugin that links scripting languages to the Google Earth Engine (GEE) in order to easily fetch geospatial information of an area for various societal issues (Zhao et al., 2021).

The open platforms for Internet of Things (IoT) such as OpenHAB, ThingSpeak and Eclipse IoT are used to equip students with practical, hands-on experiences, fostering a deep understanding of IoT concepts and technologies (Ghashim & Arshad, 2023; Hamid et al., 2022; Pereira et al., 2022). They allow students to create and manage home automation systems, providing practical experience to set up, configure, collect, visualize, and analyze data from IoT devices in real-time, fostering skills in data analytics and visualization. Likewise, students learn how to integrate IoT devices with cloud services for data storage and processing (Al Ghatrifi et al., 2023). The findings of studies (Akimov et al., 2023; Alenezi, 2019; Ramírez-Recalde et al., 2020) have documented the role of open cloud platforms like OpenStack, Cloud Foundry and Kubernets in the enhancement of teaching and learning in higher learning institutions. These platforms help students develop critical skills in cloud infrastructure management, application development, and modern software practices, preparing them for careers in cloud computing and related fields. By integrating these platforms into the curriculum, higher learning institutions can foster innovation, collaboration, and a deep understanding of cloud technologies (O'Connor & ChatGPT, 2023; Vanermen et al., 2022).

Despite the success of open platforms in promoting teaching and learning processes in higher education institutions, there are still barriers to be addressed to fully harness their potential. Studies have documented a number of technical, institutional, cultural, attitudinal, educational and pedagogical barriers regarding the integration and support of open platform technologies in teaching and learning (Polyakova, 2020; Tikhonova & Raitskaya, 2023). Ngo et al., (2023) also raised concerns regarding the security and privacy of institution, faculty and students' data, intellectual property, procurement policies, accreditation, Government regulations and standards on the use of open platforms technologies.

Understanding the benefits and barriers of open platforms in promoting teaching and learning activities is crucial. Studies have been conducted using models like the Technology Acceptance Model (TAM) proposed by Davis (1989) to measure acceptance of technology in developed economies. However, there is a lack of empirical studies focusing on the benefits and barriers of open platforms in developing countries like Tanzania. Therefore, this study is designed to establish the benefits and explore the barriers of using open platforms in teaching and learning processes by faculty members and students in Tanzania.

THEORETICAL BACKGROUND

Literature Review

Open platforms have emerged as transformative tools in higher education, providing flexible, cost-effective, and innovative solutions for teaching and learning. Educational open platforms such as Moodle and edX offer extensive resources and collaborative tools that support diverse learning styles and enhance student engagement with continuous class sessions during times of disaster like the COVID-19 pandemic. They have ensured that universities and higher learning institutions across the world experience the reality of fully remote teaching and learning at minimal costs. These platforms facilitate the creation of interactive courses, enabling educators to integrate multimedia content, quizzes, and forums that foster a collaborative learning environment. Research indicates that these platforms significantly improve access to educational resources and enable personalized learning experiences, which are essential for addressing the current diverse needs of students in higher learning institutions. Open-source software platforms like Linux, LibreOffice, Apache OpenOffice, Firefox, and GIMP further contribute to education by providing free, high-quality alternatives to proprietary software, thus reducing costs and making advanced tools accessible to all students. These platforms encourage active learning and critical thinking by enabling students to contribute to and edit content, thus improving their research and writing skills. Open platforms for Internet of Things (IoT), including openHAB, ThingSpeak, and Eclipse IoT, provide hands-on learning experiences in developing and managing IoT solutions, which are increasingly relevant in today's technology-driven world. Similarly, open cloud platforms like OpenStack, Cloud Foundry, and Kubernetes support practical learning in cloud computing, allowing students to deploy and manage scalable applications in cloud environments. These platforms are essential for teaching modern computing skills and preparing students for the demands of the contemporary job market. A wide array of educational open platform technologies, tools and services are available to promote learning experiences regardless of geographical location. This review sets the stage for exploring the research question: What benefits and barriers do faculty and students experience on using open platforms in promoting teaching and learning in higher learning institutions? This study has attempted to respond to this question.

Benefits of Open Platforms Technologies

The adoption and integration of open platforms in higher learning institutions have been significantly influenced by the usefulness and ease of use of these technologies. These concepts are central to the Technology Acceptance Model (TAM), which suggests that the likelihood of technology adoption is primarily determined by users' perceptions of its usefulness and ease of use. Perceived usefulness is defined by Davis (1989) in the context of the degree to which a person believes that using a particular system would enhance his or her job performance. Therefore, in this context it is defined as benefits users experience by using technology. In higher education, the open platforms such as Moodle and edX are viewed as highly beneficial due to their ability to provide accessible, flexible, and diverse learning resources. Moodle, for instance, supports a variety of multimedia content, forums, and quizzes, which enhances student engagement and learning outcomes (Kop et al., 2011; Pratama et al., 2023). Similarly, edX offers a wide range of courses from leading institutions, democratizing access to quality education and enabling lifelong learning.

Open-source software platforms like Linux, LibreOffice, and GNU Image Manipulation Program (GIMP) provide powerful, cost-effective alternatives to proprietary software, making advanced tools accessible to all students and educators. These platforms are particularly useful in developing countries where budget constraints often limit access to expensive software licenses (Silva et al., 2023). Moreover, platforms like GitHub and GitLab facilitate collaborative learning and project management, allowing students to work together on coding projects, share knowledge, and develop industry-relevant skills (Blincoe et al., 2016). Open platforms are designed to be user-friendly and

accessible, which significantly lowers the barriers to adoption. For instance, platforms like Wikipedia and OpenStreetMap offer intuitive interfaces that allow users to easily contribute and edit content, enhancing their research and writing skills (Okoli et al., 2014). In the realm of IoT and cloud computing, platforms like openHAB, ThingSpeak, and Eclipse IoT provide simplified environments for developing and managing IoT solutions, making it easier for students to engage in hands-on learning experiences (Ghashim & Arshad, 2023).

Theoretical Framework

The theoretical framework for examining the benefits and barriers of open platforms in promoting teaching and learning in higher learning institutions is grounded primarily in the Technology Acceptance Model (TAM). Developed by Davis (1989), TAM is a widely recognized model that explains how users come to accept and use a technology. The model suggests that two main factors influence technology adoption: perceived usefulness and perceived ease of use as shown in Figure 1 below. In perceived usefulness, this construct refers to the degree to which a person believes that using a particular system would enhance their job performance. In the context of higher education, it can be interpreted as the extent to which faculty members and students believe that open platforms such as Moodle, edX, GitHub, Linux, and others will improve their teaching and learning outcomes. Research has shown that technologies perceived as useful are more likely to be adopted and integrated into educational practices (Parvez et al., 2022). In perceived ease of use, this construct pertains to the degree to which a person believes that using a particular system would be free of effort. For open platforms, it involves the user-friendliness, accessibility, and ease of integration of these technologies into existing educational frameworks. If faculty and students find these platforms easy to use, they are more likely to incorporate them into their daily activities, thereby enhancing their educational experience (Al Ghatrifi et al., 2023; Liapis et al., 2023).

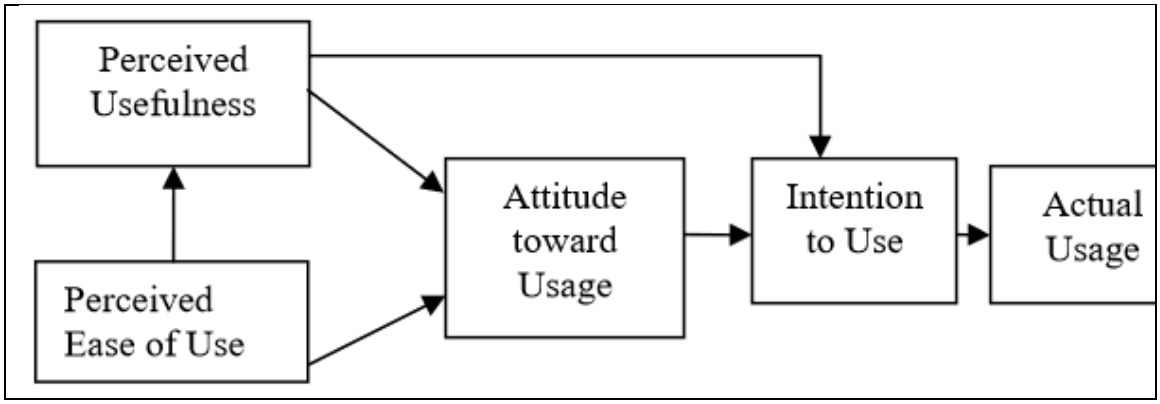

Figure 1: Technology Acceptance Model (Park & Park, 2020)

The TAM model has been extended and refined to better understand technology acceptance in different contexts. For instance, Venkatesh & Davis (2000) introduced the TAM2 model, which incorporates additional factors such as social influence and cognitive instrumental processes. In the context of open platforms in education, these extensions help to explain how peer influence, institutional policies, and technology relevance can further impact adoption and usage. Another significant extension is the Unified Theory of Acceptance and Use of Technology (UTAUT), proposed by Parvez et al., (2022). UTAUT integrates multiple user acceptance models and adds factors such as facilitating conditions and user experience. This model is particularly useful in educational settings as it considers the broader context of technology usage, including institutional support and infrastructure. Applying TAM and its extensions to the study of open platforms in higher education allows for a comprehensive understanding of the factors influencing their adoption. By

examining benefits and barriers, alongside factors like social influence, facilitating conditions, and cognitive instrumental processes, researchers can gain insights into how these platforms are beneficial and utilized by faculty and students.

METHODOLOGY

This study employed a mixed methods research design, a systematic approach that combines quantitative and qualitative research methods, sampling procedures, and data collection and analysis techniques in a single study (Creswell, 2003). The integration of these methods allows for comprehensive data collection and analysis, providing a more robust understanding of the research problem (Palinkas et al., 2015). The study aimed to determine the benefits and barriers of open platforms among teaching staff and students in higher learning institutions in Tanzania. It was conducted at the University of Dar es Salaam, Institute of Finance Management, The University of Dodoma and The Open University of Tanzania. The study population consisted of teaching staff and students from these institutions. A total of 400 respondents participated, including 350 students and 50 instructors.

A mixed sampling technique was utilized to select participants. Simple random sampling was employed to select students and instructors who completed the questionnaire, ensuring each participant had an equal chance of being chosen. Purposive sampling was used to select specific faculty members and students for interviews, allowing the researcher to deliberately choose individuals who could provide detailed and relevant insights (Bris et al., 2021; Palinkas et al., 2015). Data were collected using a cross-sectional survey method that combined questionnaires and structured interviews. This combination was necessary to address the research problem effectively, as each method has its strengths and weaknesses that complement each other when used together (Kothari & Garg, 2019). A self-administered questionnaire with both open and closed-ended questions was distributed to students and lecturers. The questionnaire was designed based on the research objectives and included general questions about the respondents' profiles, which, although not directly related to the study's objectives, provided useful background information.

In addition to the questionnaires, face-to-face interviews with key informants were conducted using open-ended questions to collect qualitative data. These interviews allowed for in-depth exploration of participants' perceptions and experiences. The data collected were subjected to both quantitative and qualitative analyses. Qualitative data were analyzed thematically, with content analysis applied to ethnographic summaries, direct quotations, and selected comments from informants. This analysis provided a nuanced understanding of the qualitative responses, complementing the quantitative findings . Quantitative data were analyzed using the Statistical Package for the Social Sciences (SPSS). Descriptive statistics, including frequencies and percentages, were calculated and presented in tables and figures to summarize the respondents' demographic characteristics and responses to the questionnaire items. By employing this mixed-methods approach, the study aimed to provide a comprehensive understanding of the benefits and barriers of open platforms in higher education, addressing both the broad trends and the detailed individual experiences of students and instructors.

RESULTS AND DISCUSSION

In this study, socio-demographic characteristics of the respondents were analyzed and summarized in Table 1. These characteristics included gender, age, designation of the respondents, and their discipline affiliation. The integration of open platforms in teaching and learning can be highly influenced by these factors. The distribution of respondents based on various characteristics was established through descriptive statistics as presented in Table 1 below.

***Table 1**: Socio-demographic Characteristics of Participants*

Characteristic	Category	Students (N=350)		Instructors (N=50)	
		Number	%	Number	%
Gender	Male	200	57.1	30	60
	Female	150	42.9	20	40
Age	< 20 years	50	14.3	0	0
	20-29 years	200	57.1	5	10
	30-39 years	80	22.9	25	50
	40-49 years	15	4.3	15	30
	50+ years	5	1.4	5	10
Designation	Undergraduate	250	71.4	-	-
	Postgraduate	100	28.6	-	-
	Assistant Lecturer			15	30
	Lecturer			20	40
	Senior Lecturer			10	20
	Professor			5	10
Discipline	Computer Science	100	28.6	20	40
	Engineering	80	22.9	10	20
	Health Sciences	50	14.3	10	20
	Social Sciences	70	20.0	5	10
	Humanities	50	14.3	5	10

The results in Table 1 show that the majority of instructor respondents (60.0%) and student respondents (57.1%) were males. These findings suggest that there are more male instructors and students at the universities where the study was conducted. Additionally, the results suggest that most students were aged between 20 and 29 years, while most instructors were aged between 30 and 39 years. The results further disclose that the respondents were distributed across various academic disciplines, with significant representation in computer science (28.6% of students and 40.0% of instructors), engineering (22.9% of students and 20.0% of instructors), and health sciences (14.3% of students and 20.0% of instructors). This indicates a diverse academic background among the respondents, reflecting the interdisciplinary nature of open platform usage in higher education**.**

To establish the extent to which the open platforms technologies are used in teaching and learning environments, the respondents were further asked to list the mostly used platforms. The data on Table 2 shows the most used open platforms among the instructors and students.

Table 2: *Most Used Open Platforms Among Instructors and Students*

Open Platform	Students(N=350)		Instructors (N=50)	
	Number	%	Number	%
Moodle	220	62.9	35	70
Google Classroom	150	42.9	25	50
Coursera	100	28.6	20	40
GitHub	90	25.7	30	60
Wikipedia	200	57.1	15	30
OpenStreetMap	80	22.9	10	20
Linux	120	34.3	30	60
LibreOffice	150	42.9	25	50
Firefox	200	57.1	35	70
GIMP	70	20.0	10	20
ThingSpeak	60	17.1	15	30
OpenStack	80	22.9	20	40
Kubernetes	70	20	20	40

The results in Table 2 show that the majority of faculty members and student respondents use Moodle, Google Classroom, and Firefox to accomplish various academic tasks. Specifically, 70.0% of instructors and 62.9% of students use Moodle, indicating its widespread adoption for managing course materials, assignments, and quizzes. Google Classroom is used by 50.0% of instructors and 42.9% of students, highlighting its role in distributing assignments, grading, and fostering communication. Firefox is utilized by 70.0% of instructors and 57.1% of students, valued for its open-source nature and customizability. Other significant platforms include Coursera, used by 40.0% of instructors and 28.6% of students, primarily for accessing a wide range of online courses to supplement learning. GitHub is essential for coding and collaborative software development projects, used by 60.0% of instructors and 25.7% of students. LibreOffice, a free alternative to proprietary office suites, is used by 50.0% of instructors and 42.9% of students for creating, editing, and sharing documents, spreadsheets, and presentations.

During interviews with key informants, students and instructors highlighted the utility of these platforms. One student remarked:

> "*Platforms like Moodle and Google Classroom make it easy to keep track of assignments and deadlines. The integration of different resources in one place is incredibly helpful*."

Similarly, a senior instructor noted:

> "*Firefox's open-source nature allows for customization to enhance the teaching experience. Additionally, using GitHub for collaborative projects helps students learn real-world software development skills*."

Platforms like Wikipedia and OpenStreetMap are used by 30.0% and 20.0% of instructors, and 57.1% and 22.9% of students respectively, primarily for reference and educational projects. One faculty member explained:

> "*Linux provides a stable and secure environment for various academic activities, especially in computer science and engineering courses. LibreOffice is a great tool for students who cannot afford expensive software*."

It was further established that the students and faculty member respondents extensively use these platforms for various academic purposes. For instance, 80.0% of students and 70.0% of instructors use open platforms for academic discussions. Sharing materials is facilitated by these platforms for 85.7% of students and 90.0% of instructors. Posting and accessing lecture notes/slides is common, with 77.1% of students and 84.0% of instructors engaging in this activity.

The respondents were further asked to indicate the purpose of using the platforms in teaching and learning activities. Table 3 shows the responses of instructors and students on the different functionalities offered by the open platforms in conducting their academic tasks.

Table 3: *Use of Open Platforms for Various Services and Functionalities*

Functionality/Service	**Students(N=350)**		**Instructors (N=50)**	
	Number	**%**	**Number**	**%**
Academic Discussion	280	80	40	80
Share Materials	300	85.7	45	90
Posting / Accessing Announcements	250	71.4	35	70
Scholarly Communication with Colleagues	200	57.1	40	80
Posting / Accessing Lecture Notes/Slides	270	77.1	42	84
Collaborative Projects	220	62.9	38	76
Research Data Management	150	42.9	30	60
Online Assessments	200	57.1	35	70
Virtual Labs	120	34.3	25	50
Coding and Software Development	90	25.7	30	60
Data Visualization and Analysis	100	28.6	30	60
Geographic Information System (GIS) Activities	80	22.9	20	40

The results in Table 3 show that 42 (84.0%) faculty members and 270 (77.1%) students make use of open platforms for posting and accessing lecture notes and slides. Meanwhile, 45 (90.0%) faculty members and 300 (85.7%) students use these platforms for sharing materials. Academic discussions are facilitated by these platforms for 40 (80.0%) of faculty members and 280 (80.0%) of students. Indeed, the findings suggest that open platforms are used in a range of academic activities. It was revealed during interviews that few lecturers were familiar with and made full use of open platforms initially. For example, one faculty member during an interview session had this to say:

> "*The adoption and use of open platforms for instructors has been a growing experience. These technologies are new and most of the instructors are from different demographic cohort: Baby boomers, Generation X and Millennials. These demographic cohort are different from the digital natives like Generation Z and Generation Alpha. Therefore, regular training is important to familiarize these groups with technological tools available to support teaching and learning*".

The findings suggest that familiarity with open platform tools and their applicability in teaching and learning was initially limited among most faculty members and students. However, once they were introduced to these tools, they recognized their value and incorporated them into their academic routines. Additionally, the data indicates that other functionalities such as online assessments, research data management, and virtual labs are also significantly supported by these open platforms. For instance, as shown in Table 3 above, 35 (70.0%) faculty members and 200 (57.1%) students use these platforms for online assessments. Research data management is facilitated by open platforms for 30 (60.0%) faculty members and 150 (42.9%) students. Virtual labs, while less

common, are still used by 25 (50.0%) faculty members and 120 (34.3%) students, among the respondents.

Benefits of Open Platforms Technologies in Teaching and Learning

The respondents were further asked about the benefits of open platform technologies to support teaching and learning. The data in Table 4, Table 5, Table 6, Table 7, Table 8 and Table 9 below illustrate the benefits of Educational Software Development and Collaboration, Open-Source Software, Open Data and Information, Open IoT and Open Cloud platforms respectively, in teaching and learning.

Table 4: *Benefits of Educational Open Platform in Teaching and Learning*

Benefits (N=400)	U	N	NT
Support students in creating ideas and contents	330 (82.5%)	50 (12.5%)	20 (5%)
Increase interactions among students and teachers	345 (86.3%)	40 (10%)	15 (3.8%)
Make students more active in teaching and learning	350 (87.5%)	35 (8.8%)	15 (3.8%)
Promote sharing of ideas and re-using study content	355 (88.8%)	35 (8.8%)	10 (2.5%)
Organize documents and resources	340 (85%)	45 (11.3%)	15 (3.8%)
Link to relevant resources and share information	360 (90%)	30 (7.5%)	10 (2.5%)
Enhance collaboration among students	365 (91.3%)	30 (7.5%)	5 (1.3%)
Accountability in the learning process	335 (83.8%)	50 (12.5%)	15 (3.8%)
Enhance critical thinking and augmentation	320 (80%)	55 (13.8%)	25 (6.3%)
Develop and critique concepts and ideas	325 (81.3%)	50 (12.5%)	25 (6.3%)
Help complete assignments and improve performance	330 (82.5%)	45 (11.3%)	25 (6.3%)
Used as a presentation tool (e-portfolios)	350 (87.5%)	40 (10%)	10 (2.5%)
Note: U=Useful, N=Neutral , NT= Not useful			

Table 5: *Benefits of Software Development and Collaboration Platform in Teaching and Learning*

Benefits (N=400)	U	N	NT
Assist in completing assignments and improving performance	330 (82.5%)	45 (11.3%)	25 (6.3%)
Facilitate the creation of student-generated content	340 (85%)	45 (11.3%)	15 (3.8%)
Increase accountability in the learning process	335 (83.8%)	50 (12.5%)	15 (3.8%)
Help organize academic resources	345 (86.3%)	40 (10%)	15 (3.8%)
Connect students and teachers to relevant resources	365 (91.3%)	25 (6.3%)	10 (2.5%)
Foster student-teacher interaction	355 (88.8%)	30 (7.5%)	15 (3.8%)
Enable development and critique of ideas	325 (81.3%)	50 (12.5%)	25 (6.3%)
Serve as tools for presentation and e-portfolios	350 (87.5%)	40 (10%)	10 (2.5%)
Aid in sharing and re-purposing study materials	355 (88.8%)	35 (8.8%)	10 (2.5%)
Support student collaboration on academic tasks	370 (92.5%)	25 (6.3%)	5 (1.3%)

Encourage student engagement in learning activities	350 (87.5%)	35 (8.8%)	15 (3.8%)
Enhance critical thinking and problem-solving	320 (80%)	55 (13.8%)	25 (6.3%)
Note: U=Useful, N=Neutral , NT= Not useful			

Table 6: *Benefits of Open-Source Software Platform in Teaching and Learning*

Benefits (N=400)	U	N	NT
Increase accountability in the learning process	335 (83.8%)	50 (12.5%)	15 (3.8%)
Facilitate the creation of student-generated content	330 (82.5%)	50 (12.5%)	20 (5%)
Foster student-teacher interaction	345 (86.3%)	40 (10%)	15 (3.8%)
Aid in sharing and re-purposing study materials	355 (88.8%)	35 (8.8%)	10 (2.5%)
Assist in completing assignments and improving performance	330 (82.5%)	45 (11.3%)	25 (6.3%)
Serve as tools for presentation and e-portfolios	350 (87.5%)	40 (10%)	10 (2.5%)
Help organize academic resources	340 (85%)	45 (11.3%)	15 (3.8%)
Connect students and teachers to relevant resources	360 (90%)	30 (7.5%)	10 (2.5%)
Support student collaboration on academic tasks	365 (91.3%)	30 (7.5%)	5 (1.3%)
Enable development and critique of ideas	325 (81.3%)	50 (12.5%)	25 (6.3%)
Enhance critical thinking and problem-solving	320 (80%)	55 (13.8%)	25 (6.3%)
Encourage student engagement in learning activities	350 (87.5%)	35 (8.8%)	15 (3.8%)
Note: U=Useful, N=Neutral , NT= Not useful			

Table 7: *Benefits of Open Data and Information Platform in Teaching and Learning*

Benefits (N=400)	U	N	NT
Increase accountability in the learning process	335 (83.8%)	50 (12.5%)	15 (3.8%)
Facilitate the creation of student-generated content	340 (85%)	45 (11.3%)	15 (3.8%)
Foster student-teacher interaction	355 (88.8%)	30 (7.5%)	15 (3.8%)
Assist in completing assignments and improving performance	330 (82.5%)	45 (11.3%)	25 (6.3%)
Support student collaboration on academic tasks	370 (92.5%)	25 (6.3%)	5 (1.3%)
Aid in sharing and re-purposing study materials	360 (90%)	30 (7.5%)	10 (2.5%)
Help organize academic resources	345 (86.3%)	40 (10%)	15 (3.8%)
Connect students and teachers to relevant resources	365 (91.3%)	25 (6.3%)	10 (2.5%)
Encourage student engagement in learning activities	350 (87.5%)	35 (8.8%)	15 (3.8%)
Enable development and critique of ideas	325 (81.3%)	50 (12.5%)	25 (6.3%)
Serve as tools for presentation and e-portfolios	350 (87.5%)	40 (10%)	10 (2.5%)
Enhance critical thinking and problem-solving	320 (80%)	55 (13.8%)	25 (6.3%)
Note: U=Useful, N=Neutral , NT= Not useful			

Table 8: *Benefits of Open Platform for IoT in Teaching and Learning*

Benefits (N=400)	U	N	NT
Facilitate the creation of student-generated content	330 (82.5%)	50 (12.5%)	20 (5%)
Increase accountability in the learning process	335 (83.8%)	50 (12.5%)	15 (3.8%)
Foster student-teacher interaction	345 (86.3%)	40 (10%)	15 (3.8%)
Assist in completing assignments and improving performance	330 (82.5%)	45 (11.3%)	25 (6.3%)
Encourage student engagement in learning activities	350 (87.5%)	35 (8.8%)	15 (3.8%)
Support student collaboration on academic tasks	360 (90%)	30 (7.5%)	10 (2.5%)
Aid in sharing and re-purposing study materials	355 (88.8%)	35 (8.8%)	10 (2.5%)
Help organize academic resources	340 (85%)	45 (11.3%)	15 (3.8%)
Connect students and teachers to relevant resources	365 (91.3%)	30 (7.5%)	5 (1.3%)
Enable development and critique of ideas	325 (81.3%)	50 (12.5%)	25 (6.3%)
Serve as tools for presentation and e-portfolios	350 (87.5%)	40 (10%)	10 (2.5%)
Enhance critical thinking and problem-solving	320 (80%)	55 (13.8%)	25 (6.3%)
Note: U=Useful, N=Neutral , NT= Not useful			

Table 9: *Benefits of Open Cloud Platform in Teaching and Learning*

Benefits (N=400)	U	N	NT
Facilitate the creation of student-generated content	340 (85%)	45 (11.3%)	15 (3.8%)
Foster student-teacher interaction	355 (88.8%)	30 (7.5%)	15 (3.8%)
Encourage student engagement in learning activities	350 (87.5%)	35 (8.8%)	15 (3.8%)
Aid in sharing and re-purposing study materials	360 (90%)	30 (7.5%)	10 (2.5%)
Help organize academic resources	345 (86.3%)	40 (10%)	15 (3.8%)
Connect students and teachers to relevant resources	365 (91.3%)	25 (6.3%)	10 (2.5%)
Support student collaboration on academic tasks	370 (92.5%)	25 (6.3%)	5 (1.3%)
Increase accountability in the learning process	335 (83.8%)	50 (12.5%)	15 (3.8%)
Enhance critical thinking and problem-solving	320 (80%)	55 (13.8%)	25 (6.3%)
Enable development and critique of ideas	325 (81.3%)	50 (12.5%)	25 (6.3%)
Assist in completing assignments and improving performance	330 (82.5%)	45 (11.3%)	25 (6.3%)
Serve as tools for presentation and e-portfolios	350 (87.5%)	40 (10%)	10 (2.5%)
Note: U=Useful, N=Neutral , NT= Not useful			

The results from Tables 4, 5, 6, 7, 8 and 9 highlight the benefits of various open platforms in the teaching and learning process across different categories, revealing insightful patterns. Across all categories, a high percentage of the instructors and student respondents agree on the benefits of these platforms in facilitating student-generated content, with the highest agreement observed in the Educational Open Platforms category (87.5%). This widespread agreement confirms the essential role these open educational platforms play in enabling students to create and share their

work. Furthermore, the results indicate strong support for these platforms in fostering student-teacher interaction, particularly within the Open Cloud Platforms category, where 88.8% of respondents agreed. This trend suggests that cloud-based solutions are highly effective in promoting communication and engagement between students and faculty, potentially due to their accessibility and integration with other educational tools. Similarly, the ability to connect students and teachers to relevant resources was highly valued, with 95.9% agreement in Educational Open Platforms and 91.3% in both Open Data and Information and Open Cloud Platforms. This agreement reflects the platforms' effectiveness in providing easy access to a wide range of educational resources, enhancing the overall learning experience. The data shown in Tables 6, 7, 8 and 9 reveal that the organization of academic resources and collaboration on academic tasks are also significant benefits recognized by the respondents. In the Open Platforms for IoT and Open Cloud Platforms categories, 90% and 92.5% of respondents respectively, acknowledged the platforms' utility in supporting collaborative academic work. This high level of agreement highlights the critical role these technologies play in facilitating teamwork and resource management, essential components of effective modern education.

Barriers of Open Platform Technologies in Promoting Teaching and Learning

Despite the fact that the majority of respondents were positive on the use of open platforms technologies in promoting teaching and learning, there are still barriers to their effective adoption. The data in Table 10 illustrates the barriers experienced by the instructors and students who participated in this study.

Table 10: *Barriers of Open Cloud Platform in Promoting Teaching and Learning*

Benefits (N=400)	Yes	No	Neutral
Lack of technical skills	260 (65%)	80 (20%)	60 (15%)
Inadequate infrastructure	280 (70%)	50 (12.5%)	70 (17.5%)
Limited internet access	300 (75%)	40 (10%)	60 (15%)
Resistance to change	220 (55%)	120 (30%)	60 (15%)
Insufficient training and support	270 (67.5%)	60 (15%)	70 (17.5%)
Financial constraints	310 (77.5%)	50 (12.5%)	40 (10%)
Concerns about data privacy and security	250 (62.5%)	90 (22.5%)	60 (15%)
Lack of institutional policies	230 (57.5%)	100 (25%)	70 (17.5%)
Incompatibility with existing systems	240 (60%)	110 (27.5%)	50 (12.5%)
Lack of awareness about open platforms	200 (50%)	140 (35%)	60 (15%)

Table 10 shows the barriers to the adoption of open platforms in promoting teaching and learning as experienced by the respondents. The most prominent barrier identified is financial constraints, with 77.5% of respondents indicating this as a challenge. This high percentage suggests that budget limitations are a critical impediment, potentially due to the costs associated with implementing and maintaining these platforms. Limited Internet access was also a major concern, noted by 75% of respondents. This barrier is particularly relevant in developing countries where Internet infrastructure may be underdeveloped, affecting the ability of both students and faculty to consistently access online resources and platforms. Similarly, inadequate infrastructure was identified by 70% of respondents as a significant barrier, highlighting the need for improved technological and physical resources within educational institutions. Another notable barrier is the lack of technical skills, with 65% of respondents affirming this challenge. This indicates a need for more comprehensive training and support to ensure that both students and instructors can effectively utilize open platforms. In line with this, 67.5% of respondents also pointed out insufficient training and support as a barrier, reinforcing the necessity for ongoing professional development

and assistance. Concerns about data privacy and security were highlighted by 62.5% of respondents, underscoring the importance of addressing security issues to build trust in these technologies. Additionally, resistance to change was cited by 55% of respondents, suggesting that cultural and attitudinal factors also play a role in the adoption of new technologies in educational settings.

DISCUSSION

The study has explored the use of various open platforms by faculty members and students in higher learning institutions, highlighting their benefits and barriers to usage. The findings reveal that diverse open platforms, including open educational resources, open-source software, open data, and cloud platforms, are utilized to support academic tasks. For instance, platforms such as GitHub, and OpenStack are employed for software development and collaboration, enhancing the ability of faculty and students to engage in code sharing and project management. Open educational resources on platforms such as Coursera and edX are extensively used for accessing and distributing educational content, supporting self-directed learning and broadening access to quality education materials. The results indicate that the benefits of open platforms significantly influences their adoption in teaching and learning activities. A substantial proportion of faculty members and students found open platforms to enhance participation, collaboration, and resource sharing, which are essential components of the academic process. Open platforms facilitate the creation and dissemination of educational content, allowing students to access a wide range of learning materials and engage in collaborative projects.

Despite the recognized benefits, the study also identified several barriers to the adoption of open platforms in higher education. The primary barriers include financial constraints, limited awareness and familiarity with these platforms, concerns about data privacy and security, and insufficient technical support. The findings suggest that while faculty members and students acknowledge the potential of open platforms to enhance teaching and learning, these barriers hinder their effective utilization. Addressing these challenges requires targeted efforts to address affordability, raise awareness, provide training and support, and ensure robust data security measures. Enhancing the integration of open platforms into the academic curriculum and providing ongoing technical support can significantly improve their adoption and utilization. The findings of this study contribute to the existing literature on the use of open platforms in higher education, providing insights into the factors influencing their adoption and utilization. By highlighting the benefits and barriers to the use of open platforms, this study underscores the need for higher learning institutions to develop strategies that promote the effective integration of these technologies. Future research should focus on exploring additional factors that influence the adoption of open platforms and developing frameworks to support their implementation in diverse educational contexts.

CONCLUSION AND RECOMMENDATIONS

Based on the study findings, it is evident that open platforms are viable in today's teaching and learning environment in Tanzanian universities. The most notable benefits of these technologies in academic activities identified in this study is ensuring collaboration in knowledge production, communication, and the development of new ideas by students and faculty members. The open platforms most frequently used for sharing course content and bibliographic information include GitHub, Coursera, edX, OpenStack, and various open data platforms. It is evident from the findings that the application of these technologies tends to improve the performance of students and faculty members and makes them more accountable for their learning processes. Moreover, it has been noted that open platforms help in creating portable and interactive educational portfolios that support students' management of their learning activities. Eventually, if properly integrated, open platforms could support more activity-oriented and student-centered teaching, providing opportunities for students to develop their personal learning environments. To strengthen the

application of open platforms in teaching and learning, faculty members should be encouraged to integrate them into their teaching activities. It is also recommended that faculty members develop habits of attending short training sessions aimed at enhancing their knowledge and skills in the application of open platforms in academic activities. Improvement of ICT infrastructure is necessary in higher learning institutions, including the acquisition and installation of modern ICT infrastructures such as computers, wireless Internet connectivity, fiber optic networks, and high Internet bandwidth. Furthermore, technical support on the use of open platforms should be provided to faculty members and students. Support from ICT experts on the proper design and use of open platforms in teaching and learning activities is highly recommended. Organizing regular workshops and training sessions for faculty members and students on how to use open platforms to accomplish academic activities is important for the smooth use of these technologies.

REFERENCES

Afi Normawati. (2021). The Implementation of Blended Learning in Teaching Reading. *English Language and Education Spectrum*, vol. 1, no. 2. https://doi.org/10.53416/electrum.v1i2.26

Akimov, N., Kurmanov, N., Uskelenova, A., Aidargaliyeva, N., Mukhiyayeva, D., Rakhimova, S., Raimbekov, B., & Utegenova, Z. (2023). Components of education 4.0 in open innovation competence frameworks: Systematic review. *Journal of Open Innovation: Technology, Market, and Complexity*, vol. 9, no. 2. https://doi.org/10.1016/j.joitmc.2023.100037

Al Ghatrifi, M. O. M., Al Amairi, J. S. S., & Thottoli, M. M. (2023). Surfing the technology wave: An international perspective on enhancing teaching and learning in accounting. *Computers and Education: Artificial Intelligence*, vol. *4*. https://doi.org/10.1016/j.caeai.2023.100144

Alenezi, F. Y. (2019). The role of cloud computing for the enhancement of teaching and learning in Saudi Arabian universities in accordance with the social constructivism theory: A specialist's point of view. *International Journal of Emerging Technologies in Learning*, vol. 14, no. 13. https://doi.org/10.3991/ijet.v14i13.9557

Azzam, A. (2017). Embracing Wikipedia as a teaching and learning tool benefits health professional schools and the populations they serve. *Innovations in Global Health Professions Education*. https://doi.org/10.20421/ighpe2017.01

Bitakou, E., Ntaliani, M., Demestichas, K., & Costopoulou, C. (2023). Assessing Massive Open Online Courses for Developing Digital Competences among Higher Education Teachers. *Education Sciences*, vol. 13, no. 9. https://doi.org/10.3390/educsci13090900

Blincoe, K., Sheoran, J., Goggins, S., Petakovic, E., & Damian, D. (2016). Understanding the popular users: Following, affiliation influence and leadership on GitHub. *Information and Software Technology*, vol. *70*. https://doi.org/10.1016/j.infsof.2015.10.002

Bris, A., Wang, T. Y. H., Zatzick, C. D., Miller, D. J. P., Fern, M. J., Cardinal, L. B., Gregoire, D. A., Shepherd, D. A., Westphal, J. D., Shani, G., Troster, C., Van Quaquebeke, N., Lanaj, K., Hollenbeck, J. R., Ilgen, D. R., Barnes, C. M., Harmon, S. J., Feldman, E. R., DesJardine, M. R. Sangiorgi, F. (2021). KNIGHTS, RAIDERS, AND TARGETS - THE IMPACT OF THE HOSTILE TAKEOVER - COFFEE,JC, LOWENSTEIN,L, ROSEACKERMAN,S. *Journal of Banking & Finance* vol. 37, no. 1.

Chakraborty, S., Gonzalez-Triana, Y., Mendoza, J., & Galatro, D. (2023). Insights on mapping Industry 4.0 and Education 4.0. *Frontiers in Education*, *8*. https://doi.org/10.3389/feduc.2023.1150190

Chen, Y., Gao, B., & Cao, H. (2022). Teaching Intelligence System Based on the Cloud Platform of the Internet of Things and Its Application in Physical Education. *Wireless Communications and Mobile Computing*, *2022*. https://doi.org/10.1155/2022/7523529

Creswell, J. W. (2003). Research design Qualitative quantitative and mixed methods approaches. *Research Design Qualitative Quantitative and Mixed Methods Approaches*. https://doi.org/10.3109/08941939.2012.723954

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly: Management Information Systems*, vol. 13, no. 3. https://doi.org/10.2307/249008

Egorov, E. E., Prokhorova, M. P., Lebedeva, T. E., Mineeva, O. A., & Tsvetkova, S. Y. (2021). Moodle LMS: Positive and Negative Aspects of Using Distance Education in Higher Education Institutions. *Propósitos y Representaciones*, vol. 9 (SPE2). https://doi.org/10.20511/pyr2021.v9nspe2.1104

Eremeev, M. A., Trubienko, O. V., & Zakharchuk, I. I. (2022). Applying a reproducible research approach to distance education. *Russian Technological Journal*, vol. 10, no. 4. https://doi.org/10.32362/2500-316x-2022-10-4-86-92

Fedosov, A. Y., & Markushevich, M. V. (2021). Elements of the methodology of teaching vector graphics based on the free graphic editor LibreOffice Draw at the level of basic general education. *Informatics in School*, vol. 1, no. 9. https://doi.org/10.32517/2221-1993-2021-20-9-4-13

Flatscher, R. G. (2023). Proposing ooRexx and BSF4ooRexx for Teaching Programming and Fundamental Programming Concepts. *Proceedings of the Information Systems Education Conference, ISECON*, *2023-March*.

Ghashim, I. A., & Arshad, M. (2023). Internet of Things (IoT)-Based Teaching and Learning: Modern Trends and Open Challenges. *Sustainability*, vol. 15, no.21. https://doi.org/10.3390/su152115656

Haleem, A., Javaid, M., Qadri, M. A., & Suman, R. (2022). Understanding the role of digital technologies in education: A review. *Sustainable Operations and Computers*, vol. *3*. https://doi.org/10.1016/j.susoc.2022.05.004

Hamid, A., Syukri, M., Halim, A., & Irwansyah, I. (2022). Development of Internet of Things Based Learning Media Through STEM Investigative Science Learning Environment Approach to Improve Student Learning Outcomes. *Jurnal Penelitian Pendidikan IPA*, vol. 8, no. 4. https://doi.org/10.29303/jppipa.v8i4.1634

Klochko, O., & Shayyhin, O. (2023). Formation of Competencies of Collective Software Development of Students in the field of Information technology in the process of using free software, *The Sources of Pedagogical Skills*, vol. *31*. https://doi.org/10.33989/2075-146x.2023.31.283329

Kop, R., Fournier, H., & Mak, J. S. F. (2011). A pedagogy of abundance or a pedagogy to support human beings? Participant support on massive open online courses. *International Review of Research in Open and Distance Learning*, vol. 12, no. 7 (SPECIAL ISSUE). https://doi.org/10.19173/irrodl.v12i7.1041

Kothari, C., & Garg, G. (2019). Kothari Research Methodology Methods. In *Jurnal Penelitian Pendidikan Guru Sekolah Dasar,* vol. 6, (August).

Liapis, A., Maratou, V., Panagiotakopoulos, T., Katsanos, C., & Kameas, A. (2023). UX evaluation of open MOOC platforms: a comparative study between Moodle and Open edX combining user interaction metrics and wearable biosensors. *Interactive Learning Environments*, vol. 31, no. 10. https://doi.org/10.1080/10494820.2022.2048674

Miloradović, M., & Milovanović, A. (2022). Data streaming architecture based on Apache Kafka and GitHub for tracking students' activity in higher education software development courses. *E-Business Technologies Conference Proceedings*, vol. 2, no. 1.

Mwantimwa, K., & Elia, E. (2019). Utilisation of e-resources to support teaching and research in higher learning institutions, Tanzania. *University of Dar Es Salaam Library Journal*, vol. 12, no. 2.

Neri, I. (2023). Expanding Digital Design Workflows with Geospatial Analytics: Linking Grasshopper3D with Google Earth Engine. *Journal of Digital Landscape Architecture*, *2023*(8). https://doi.org/10.14627/537740047

Ngo, T. T. A., Tran, T. T., An, G. K., & Nguyen, P. T. (2023). Students' Perception Towards Learning Massive Open Online Courses on Coursera Platform: Benefits and Barriers. *International Journal of Emerging Technologies in Learning*, vol. 18, no. 14. https://doi.org/10.3991/ijet.v18i14.39903

O'Connor, S., & ChatGPT. (2023). Open artificial intelligence platforms in nursing education: Tools for academic progress or abuse? In *Nurse Education in Practice,* vol. 66. https://doi.org/10.1016/j.nepr.2022.103537

Okoli, C., Mehdi, M., Mesgari, M., Nielsen, F. Å., & Lanamäki, A. (2014). Wikipedia in the eyes of its beholders: A systematic review of scholarly research on Wikipedia readers and readership. *Journal of the Association for Information Science and Technology*, vol. 65, no. 12. https://doi.org/10.1002/asi.23162

Palinkas, L. A., Horwitz, S. M., Green, C. A., Wisdom, J. P., Duan, N., & Hoagwood, K. (2015). Purposeful Sampling for Qualitative Data Collection and Analysis in Mixed Method Implementation Research. *Administration and Policy in Mental Health and Mental Health Services Research*, vol. 42, no. 5. https://doi.org/10.1007/s10488-013-0528-y

Park, E. S., & Park, M. S. (2020). Factors of the technology acceptance model for construction IT. *Applied Sciences (Switzerland)*, vol. 10, no. 22. https://doi.org/10.3390/app10228299

Parvez, M. O., Arasli, H., Ozturen, A., Lodhi, R. N., & Ongsakul, V. (2022). Antecedents of human-robot collaboration: theoretical extension of the technology acceptance model. *Journal of Hospitality and Tourism Technology*, vol. 13, no. 2. https://doi.org/10.1108/JHTT-09-2021-0267

Pereira, R., de Souza, C., Patino, D., & Lata, J. (2022). PLATFORM FOR DISTANCE LEARNING OF MICROCONTROLLERS AND INTERNET OF THINGS. *Ingenius*, *2022*(28). https://doi.org/10.17163/ings.n28.2022.05

Pholld Mwakyusa, W., & Masome Ng`webeya, L. (2022). The Response of Tanzania Higher Learning Institutions to e- Learning during Covid-19 Pandemic. *EAST AFRICAN JOURNAL OF MANAGEMENT AND BUSINESS STUDIES*, vol. 2, no. 1. https://doi.org/10.46606/eajess2022v03i01.0142

Polyakova, T. (2020). Engineering pedagogy: On the way to "education 4.0." *International Journal of Engineering Pedagogy*, vol. 10, no. 4. https://doi.org/10.3991/ijep.v10i4.15021

Pratama, W., Pardjono, Wibowo, W., Astriawati, N., Iryanti, H. D., & Arroyo, E. T. (2023). Developing Cadets' Soft Skills through Project-Based Learning in Moodle LMS. *Journal of Engineering Education Transformations*, vol. 36, no. 4. https://doi.org/10.16920/jeet/2023/v36i4/23123

Ramirez-Montoya, M. S., Weber, J. C., Cox, G., & Tenorio-Sepulveda, G. C. (2024). Inclusive Digital Education on Open Platforms: A Case Study of the Complexity of the Future of Education. *Computers in the Schools*. https://doi.org/10.1080/07380569.2024.2322164

Ramírez-Recalde, A. C., Umaquinga-Criollo, A. C., Maya-Olalla, E. A., & Vásquez, C. A. (2020). Methodology of teaching and learning in cloud computing technologies: A case study in the career of electronic engineering and communication networks of the "universidad técnica del norte." *RISTI - Revista Iberica de Sistemas e Tecnologias de Informacao*, *2020*(E25).

Silva, D. G., Coutinho, C., & Costa, C. J. (2023). Factors influencing free and open-source software adoption in developing countries—an empirical study. *Journal of Open Innovation: Technology, Market, and Complexity*, vol. 9, no. 1. https://doi.org/10.1016/j.joitmc.2023.01.002

Talib, C. A., Aliyu, H., Malik, A. M. A., Siang, K. H., Novopashenny, I., & Ali, M. (2019). Sakai: A mobile learning platform. *International Journal of Interactive Mobile Technologies*, vol. 13, no. 11. https://doi.org/10.3991/ijim.v13i11.10800

Tarigan, J. T., Zamzami, E. M., Jaya, I., Hardi, S. M., & Zarlis, M. (2019). Ability level of git hub amongst computer science students. *International Journal of Recent Technology and Engineering*, vol. 8, no. 2 (Special Issue 7). https://doi.org/10.35940/ijrte.B1028.0782S719

Tikhonova, E., & Raitskaya, L. (2023). Education 4.0: The Concept, Skills, and Research. In *Journal of Language and Education* vol. 9, no. 1. https://doi.org/10.17323/JLE.2023.17001

Vanermen, L., Vlieghe, J., & Decuypere, M. (2022). Curriculum meets platform: A reconceptualisation of flexible pathways in open and higher education. *Curriculum Inquiry*, vol. 52, no. 4. https://doi.org/10.1080/03626784.2022.2120347

Venkatesh, V., & Davis, F. D. (2000). Theoretical extension of the Technology Acceptance Model: Four longitudinal field studies. *Management Science*, vol. 46, no. 2. https://doi.org/10.1287/mnsc.46.2.186.11926

Vlasenko, K. V., Volkov, S. V., Lovianova, I. V., Sitak, I. V., Chumak, O. O., & Bohdanova, N. H. (2023). Exploring usability principles for educational online courses: a case study on an open platform for online education. *Educational Technology Quarterly*, *2023*(2). https://doi.org/10.55056/etq.602

Wever, R., Ruiz, J. F., & Bengtsson, M. (2023). AN OPEN EDUCATION PLATFORM: LEARNING OUR WAY TO MIXING LIFE-LONG LEARNERS AND REGULAR STUDENTS. *Proceedings of the 25th International Conference on Engineering and Product Design Education: Responsible Innovation for Global Co-Habitation, E and PDE 2023*. https://doi.org/10.35199/epde.2023.100

Yamamoto, T., Shih, J., Pang, C., & Ong, B. (2019). Proposing curriculum and learning environment development for global liberal arts education incorporating future work skills. *ICCE 2019 - 27th International Conference on Computers in Education, Proceedings*, *1*.

Zhao, Q., Yu, L., Li, X., Peng, D., Zhang, Y., & Gong, P. (2021). Progress and trends in the application of google earth and google earth engine. In *Remote Sensing* vol. 13, no. 18. https://doi.org/10.3390/rs13183778
