EVALUATION OF CONTEMPORARY EASSESSMENT PLATFORMS: FUNCTIONAL REQUIREMENTS AND TECHNOLOGICAL APPROACHES

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АНАЛИЗ НА СЪВРЕМЕННИ ПЛАТФОРМИ ЗА ЕОЦЕНЯВАНЕ: ФУНКЦИОНАЛНИ ИЗИСКВАНИЯ И ТЕХНОЛОГИЧНИ РЕШЕНИЯ

Abstract

Assessment is an extremely important process in an education, which is used as a measure of the acquired knowledge and skills of the learners. In the modern world, a number of technological tools and platforms have been developed to support activities related to eAssessment performed by the learner and teacher. The purpose of the paper is to present research conducted on contemporary approaches for assessment, technological specificity, advantages and disadvantages. For this purpose, a study of the scientific production in the field is performed, and the achievements are summarized and discussed. A criteria set is created for drawing the requirements for future building of a technological solution of an assessment platform. Particular attention is paid to security and protection of personal data, collected and transferred during the assessment process.

Keywords: Assessment Platforms; Functional Requirements; Technological Implementation; Learning Analytics, Security; Data Protection.

INTRODUCTION

The educational process has the purpose to give the necessary knowledge and skills to the students, thereby preparing them for their future professional realization. What is the level of these knowledge and skills is usually assessed by the teachers after the completion of specific assessment tasks. The assessment is formative, showing the students progress in product creation/knowledge gaining and summative which is related to evaluation of the final product/obtained knowledge [1], [2]. Another type of assessment is diagnostic that is applied to pre-identify the knowledge gap or to pre-determine the knowledge level of students. Currently, a part of the assessment tasks are carried out in an online environment, which is driven by the development of technologies and the growing demands from all participants in education to implement a high quality and high tech assessment process [3], [4]. Students growing up in the age of technology want to receive a modern technology-based education, and the assessment environment also must offer various opportunities for performing a variety of assessment activities, receiving an objective result, and providing rapid feedback. The demands of teachers have increased too, which are aimed at realizing the capabilities of the environment to support and automate their assessment activities to achieve a reduction in time and required effort [5]. To meet these high requirements, contemporary eAssessment environments also include learning analytics functions, as well as machine learning and artificial intelligence techniques to process the educational data and to present the extracted information in suitable form [6], [7]. At the same time, the environment must possess features related to secure data transfer and data preservation [8].

The aim of the paper is to present an exploration regarding the current scientific achievements in assessment of students, drawing the most researched and discussed topics. A set of criteria to be created for defining the requirements of the contemporary assessment environment and also to present the developed functional architecture of such an environment.

USED METHODOLOGY

Assessment is conducted in eLearning system environments through the functions available in them or in environments specially designed only to manage an assessment process. In order to outline the current picture of scientific research in the field of assessment, two queries are submitted to the Scopus database. One is "students and assessment" to gain knowledge and better understanding of the discussed research topics concerning students' assessment. The second query "learning management system and assessment" is aimed at investigating the role of eLearning systems in the assessment process. When submitting the first request, 207 160 documents are returned, and the result of the second query is 1 879 documents. After that, the results are limited by time, taking into account only those included in the period 2020-2024. The number of documents after applying this criterion is 75 389 for the first request and 874 for the second. Documents are ordered according to their relevance to the investigated topic. The bibliometric data of the first 5000 documents from the first query "students and assessment" and all documents from the second query "learning management system and assessment" are extracted for post-processing and analysis using R software and biblioshiny application [9].

The research questions posed are related to: 1. What is the importance and interest in the theme concerning students' assessment?, 2. What issues are being discussed and researched?.

THE GENERAL PICTURE AT BIBLIOMETRIC ANALYSIS

The importance and interest of the researched theme can be judged by the number of publications in recent years, the number of involved authors, collaboration among countries as well as by the number of citations. Information about the result of the first query "students and assessment" is summarized in Table 1. The investigated first 5000 documents are published in 1793 sources as the 10 most relevant of them are: ASEE Annual Conference and Exposition (Conference Proceedings), Assessment and Evaluation in Higher Education, ACM International Conference Proceeding Series, Journal of Physics: Conference Series, Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics), BMC Medical Education, Frontiers in Education, Currents in Pharmacy Teaching and Learning, AIP Conference Proceedings, Education Sciences. If a thematic analysis of the sources is done, it can be seen that it is mainly published in education and computer science journals, books and proceedings, which also indicates the degree of importance of technologies and technological solutions to support the assessment process of students. Average each document is cited by 4 other documents in this short period we are exploring, which outlines the interest in the theme. The large number of used references indicates the great scientific output and scientific achievements in the field. The number of authors is also significant 13763, with an average of three co-authors preparing a paper. The importance of the cooperation of authors from different countries is also considered as international co-authorship is 12.56%. Authors from the USA (780 documents), China (318), Australia (247), Great Britain (220), Indonesia (213) and India (115) have the largest scientific output. Countries whose authors are among the most cited and have a leading influence in the scientific community are USA (Total Citations (TC) 3454), Australia (TC 1724), China (TC 1512), Spain (TC 1120), United Kingdom (1010), Hong Kong (TC 562).

Table 1. Main information about the result of the first query "students and assessment"

| Criteria	Data
Timespan	2020:2024
Sources (Journals, Books, etc)	1793
Documents	5000
Average citations per doc	4
References	157441
Keywords Plus	8040
Author's Keywords	9135
Authors	13763
Single-authored docs	804
Co-Authors per Doc	3.32
International co-authorships%	12.56
Scientific output	USA (780), China (318), Australia (247), Great Britain (220), Indonesia (213) and India (115)
The most cited countries	USA (TC 3454), Australia (TC 1724), China (TC 1512), Spain (TC 1120), United Kingdom (1010), Hong Kong (TC 562)

In order to understand what kind of issues and problems are most often researched and discussed, the author's keywords and key terms used by them in the title and abstract of the papers are explored. A summary of the top ten most frequently used terms is presented in Table 2. The terms **peer assessment** and **online assessment** appeared among the most frequently used in all three categories - as keywords to describe the content of articles, as terms in the titles and abstracts of these articles. The researchers seem to consider issues related to peer and online assessment to be particularly current. Formative assessment is found in author keywords and article titles, which is an indication of very common use of this type of assessment. The terms **students learning** and **assessment tool** are found in the titles and abstracts of the articles, which emphasizes the significant role of assessment in the learning process, as well as the need of educators to select appropriate assessment tools corresponding to different learning characteristics.

Co-occurrence network is constructed to understand the relationship among used authors' keywords and which ones are utilized jointly that tells about the issues under consideration and discussion in the articles (Fig. 1). Three clusters emerged, and the first one (in green color) includes a variety of terms indicating the diversity of topics considered by the authors, namely different forms of assessment (formative, summative, continuous, peer, self-assessment), student motivation and commitment (student engagement, motivation), the role of assessment for learning process (blended learning, active learning, collaborative learning, academic performance, self-efficacy), learning analytics in assessment, others. The second largest cluster (in blue color) brings together terms in the fields of online learning and online assessment, academic integrity and the application of machine learning and artificial intelligence. The smallest cluster (in red color) consists of only two concepts: reliability and validity that are also important terms in realization of trustful assessment. The terms in the three clusters are not isolated, thye are connected with a number of other terms from the same or other clusters.

As a summary considering the terms used by the authors, a classification of the investigated topics can be made: 1. related to the forms of assessment, 2. to practices, methods and tools for assessment, 3. to the learning process of the learners, 4. to the context of the assessment application.

Table 2. The most frequently used terms by authors in keywords, titles and abstracts

Author's keywords		Terms in titles		Terms in abstracts	
Keyword	**Occurrences**	**Term**	**Occurrences**	**Term**	**Occurrences**
assessment	857	formative assessment	271	**peer assessment**	882
formative assessment	349	**peer assessment**	178	student learning	661
self-assessment	262	medical students	132	learning outcomes	630
higher education	247	school students	100	assessment practices	500
peer assessment	180	covid-pandemic	85	students learning	500
feedback	159	assessment tool	83	medical students	437
online assessment	99	student learning	80	assessment methods	409
education	96	nursing students	76	assessment tool	381
covid-19	92	college students	73	**online assessment**	347
students	84	**online assessment**	73	student performance	341
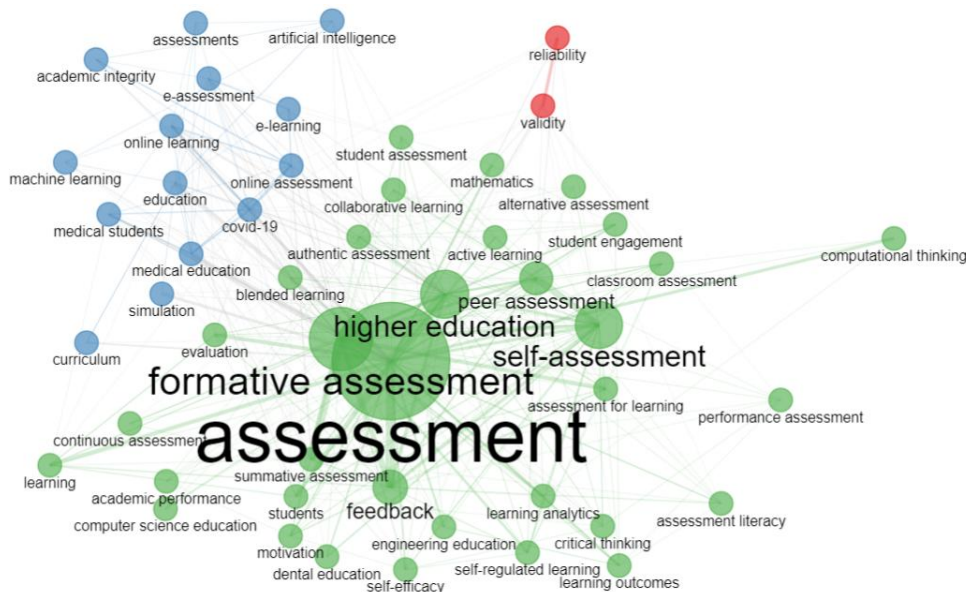
Fig. 1. Co-occurrence network

The returned result from the second query "learning management system and assessment" is in the form of a list with fewer documents due to its more specific and less general definition (Table 3). These documents are mainly published in educational and computer science journals, books series and conference proceedings like: ASEE Annual Conference and Exposition Conference Proceedings, ACM International Conference Proceeding Series, AIP Conference Proceedings, IEEE Access, International Journal of Emerging Technologies in Learning, Proceedings - Frontiers In Education Conference, International Journal of Advanced Computer Science and Applications, Journal of Engineering Education Transformations, Journal of Physics: Conference Series, Lecture Notes in Networks and Systems. The source scope is

evidence that the issues discussed concern both educational and pedagogical topics as well as technological issues related to computer science topics. In this small research period of 2020-2024, each paper has an average of 5.5 citations, which could be explained with the quality and significance of the obtained scientific achievements. A large part of the documents are prepared in collaboration with an average of 3 authors per document. In 13.96% of the articles, at least one author is from another country. The main contributing authors are from the USA (85 documents), Indonesia (48), India (36), Australia (32), China (23), Saudi Arabia (22) as they are also among the most cited authors: the USA (TC 622), Australia (TC 479), Saudi Arabia (TC 201), and India (TC 186).

Table 3. Main information about the result of the second query "learning management system and assessment"

Criteria	Data
Timespan	2020:2024
Sources (Journals, Books, etc)	483
Documents	874
Document Average Age	2.03
Average citations per doc	5.501
References	27703
Keywords Plus	3134
Author's Keywords	2268
Authors	2755
Single-authored docs	105
Co-Authors per Doc	3.35
International co-authorships%	13.96
Scientific output	USA (85), Indonesia (48), India (36), Australia (32), China (23), Saudi Arabia (22)
The most cited countries	USA (TC 622), Australia (TC 479), South Africa (TC 285), Saudi Arabia (TC 201), Pakistan (TC 187) and India (TC 186)

In order to understand the content of the articles, the keywords used by the authors that best describe the discussed topic are studied, the terms used to define the titles of the articles and the terms included in the abstract are also investigated. Excluding the concepts learning management system and covid, the terms that occur in all three categories are **learning analytics** and **online learning**. It can be seen that very often the authors are interested in research related to conducting assessment tasks in an online environment of learning management systems, as well as problems that concern learning analytics. In the titles and abstracts of the papers the most often the term **student learning** is included which again emphasizes the importance of assessment for the students' learning process and the use of technological solutions for the implementation of modern forms of assessment.

The created co-occurrence network (Fig. 2) is presented to see the used terms by authors in their article and to understand the main investigated topics. The co-occurrence network consists of three bigger and two very small clusters. The biggest one is formed around the keyword learning management system (in red color) that is connected with terms like: assessment, e-learning, higher education, others. The second cluster (in green color) is organized around the term learning analytics and includes terms such as: moodle, automated assessment, machine learning, educational data mining, blended learning, online education, self-regulated learning, others. The third cluster especially addresses the topics related to online forms of learning, teaching and assessment (in blue color). The first small cluster is focused on

terms teaching and learning (in lilac color), and the last one includes the term active learning (in orange color). It outlines the central role of assessment and its technological support for realization of contemporary forms of learning and teaching.

Table 4. The most frequently used terms by authors in keywords, titles and abstracts

Author's keywords		Terms in titles		Terms in abstracts	
Keyword	**Occurrences**	**Term**	**Occurrences**	**Term**	**Occurrences**
learning management system	158	learning management	137	learning management	888
e-learning	74	management system	81	management system	588
learning analytics	63	management systems	55	management systems	312
learning management systems	63	**online learning**	43	**online learning**	253
higher education	54	**learning analytics**	34	system lms	190
covid-19	48	covid-pandemic	33	covid-pandemic	147
assessment	47	blended learning	16	**learning analytics**	146
online learning	47	formative assessment	16	learning process	111
moodle	38	machine learning	13	learning outcomes	103
lms	37	student learning	13	students learning	94
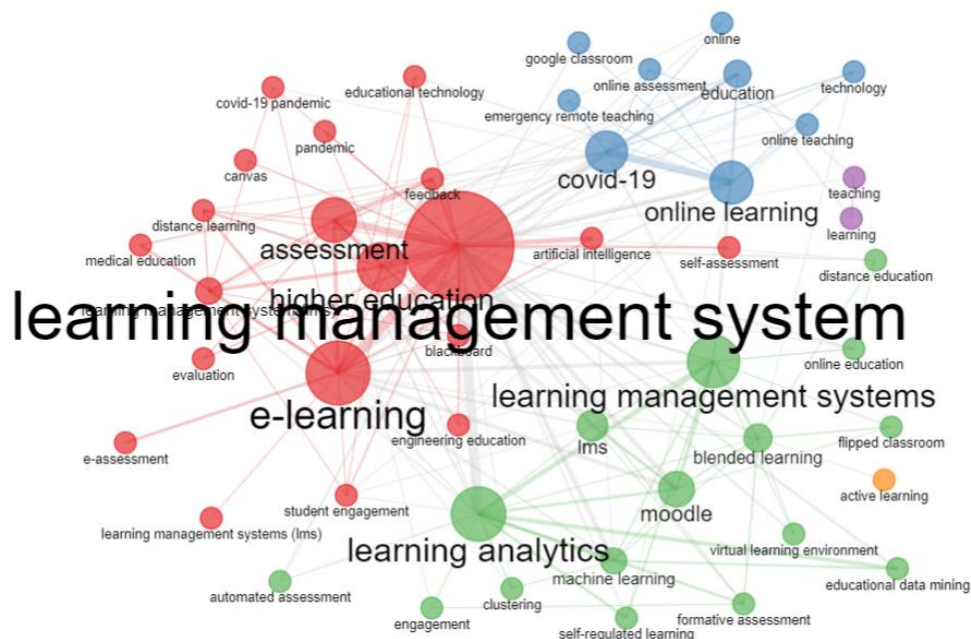
Fig. 2. Co-occurrence network

In summary, the terms characterizing the query "learning management system and assessment" can be classified into the following groups: 1. to implement different forms of learning (online, blended, distance, self-regulated, active) and education (higher, vocational, engineering), 2. to integrate and develop contemporary technologies (machine learning, artificial intelligence, educational data mining, learning analytics). 3. to realize various forms of assessment (formative, summative, self-assessment), 4. to discuss the learners' results (learning performance, learning outcomes), 5. to utilize learning management systems (the most often is discussed moodle).

FUNCTIONAL ARCHITECTURE OF AN ASSESSMENT ENVIRONMENT

The performed bibliometric analysis indicates the increased interest of the research community in the assessment process and its technological support, which stems from the key role of assessment for student success, the rapid development of technologies and the high demands of students and teachers for a high-tech educational environment and quality training. Among the contemporary topics discussed are those related to the introduction of artificial intelligence and machine learning to support the assessment, learning analytics and automation of activities that characterize it. Considering the created general picture regarding important issues in assessment and our gained educational experience leads to preparation of a set with requirements with intention to facilitate development of assessment online platform for school students. Table 5 summarizes the main functional and technical requirements. Among the key functional requirements are those related to realization of tools in support of four types of assessment forms (formative, summative, diagnostic and self-assessment), four types of assessment tasks (quiz, essay, project, collaborative assessment), two types of feedback delivery (synchronous, asynchronous), learning analytics (statistics and visualizations to facilitate students' progress and teaching practice) and artificial techniques for automating the students assessment assignments and teachers assessment related tasks.

Table 5. Functional and technical requirements of assessment online platform

| Functional requirements		Technical requirements	
Type of assessment mode	Formative	Open source technologies	Cost free
	Summative		
	Diagnostic		
	Self		
Type of assessment tasks	Quiz	Modularity	Easy extension with additional functionality
	Essay		
	Project		
	Collaborative assignment		
Feedback	Synchronous	Cloud based	Easy infrastructure maintains
	Asynchronous		
Learning analytics	Statistics	Architecture	Client/server, including mobile clients
	Visualizations		
Artificial intelligence	In support of students	User friendly front end design	Rich students experience
	In support of teachers		

The technical requirements are related to the implementation of a software architecture that is cost-effective (usage of open source technologies and cloud-based services), flexible and extensible (through modules), with the possibility of access from different devices (laptops, smart phone and tablets), obtaining rich educational experience by students (through user friendly front end design).

Special attention is paid to the principle of implementing security and privacy "by design" and the main requirements for security mechanisms and GDPR-based (General Data Protection Regulation) techniques are presented in Table 6.

The created functional architecture is presented on Fig. 3, showing the main functions to facilitate: 1. teacher, when developing instructions, assessment tasks and feedback; to automate, semi-automate or to allow manual scoring of assessment; to obtain timely analytical statistics; 2. student when completing personalized assessment tasks or collaborative assessment activity, to analyse and visualize his/her progress.

Table 6. Requirements concerning security and privacy of assessment online environment

Requirements regarding security and privacy	
Security	E-authentication
	Authorship check
	Documents exchange
	Documents storage
Privacy GDPR-based	*Lawfulness, fairness and transparency* – to be informed for data collection
	Limiting purposes – for assessment purpose
	Data minimization – min data at registration
	Accuracy – actual data maintains
	Storage limitation - while they are students
	Integrity and confidentiality – for assessment process only
	Accountability – full documentation
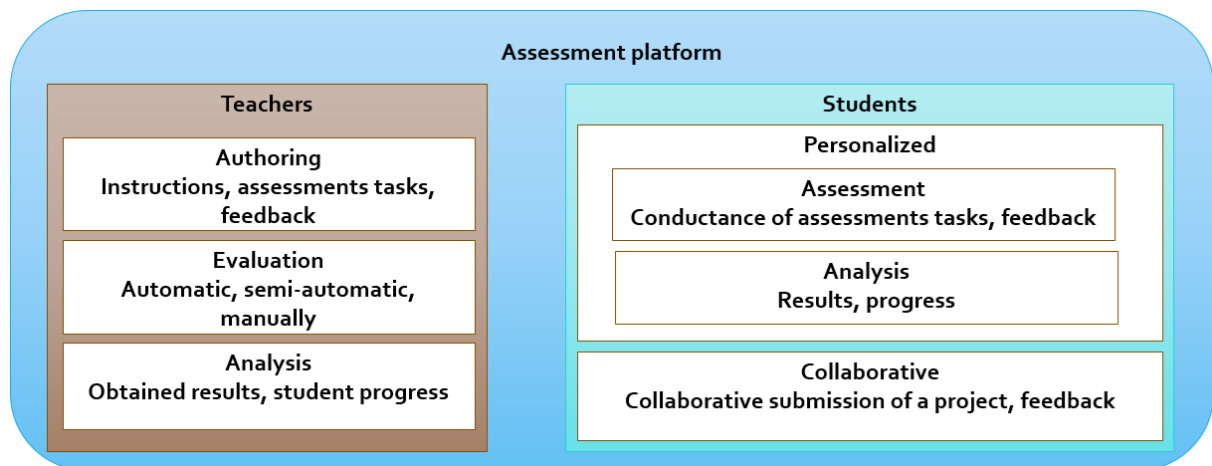
Fig. 3. Functional architecture of an assessment platform

CONCLUSION

In the paper, a bibliometric analysis is conducted, which presents a wide range of issues that have been researched and discussed in the field of assessment and its technological support. The scientific production in the last few years (2020-2024) is studied in order to outline the contemporary global picture in the assessment area as an extremely large number of publications is found in Scopus database that is a sign of the importance and relevance of the treated issues. The most frequently used terms by the authors can be classified into several groups: 1. terms related to different types of assessment, 2. different forms of learning, 3. used contemporary technologies in assessment, 4. obtained results by learners in the educational

process, 5. good practices, assessment methods and tools. The most often used keywords are *peer assessment*, *online assessment*, *students learning*, *assessment tool* and *learning analytics*, showing the key role of online assessment for the learning process of students and the meaning of learning analytics techniques in support of students and teachers' activities in assessment.

A list with functional and technical requirements for building a contemporary online assessment platform for school purposes is created as well as a functional architecture of such software is proposed. Special attention is paid to measures planned for implementation of security and GDPR-based privacy of the data collected in the assessment process.

REFERENCES

1. Onasanya, S. A., Ajamu, A. O., Formative and Summative Assessment Using Technology: A Critical Review, Mimbar Ilmu, 29(1), 1-8, 2024. https://doi.org/10.23887/mi.v29i1.72042

2. Buchholtz, N. F., Krosanke, N., Orschulik, A. B. et al., Combining and integrating formative and summative assessment in mathematics teacher education, ZDM Mathematics Education 50, 715-728, 2018. https://doi.org/10.1007/s11858-018-0948-y

3. Al-Maqbali, A. H., Al-Shamsi, A., Assessment Strategies in Online Learning Environments During the COVID-19 Pandemic in Oman, Journal of University Teaching & Learning Practice, 20(5), 2023. https://doi.org/10.53761/1.20.5.08

4. Serutla, L., Mwanza, A., Celik, T., Online Assessments in a Changing Education Landscape, Reimagining Education - The Role of E-Learning, Creativity, and Technology in the Post-Pandemic Era, 2024. https://doi.org/10.5772/intechopen.1002176

5. Paiva, J. C., Leal, J. P., Figueira, A., Automated Assessment in Computer Science Education: A State-of-the-Art Review, ACM Transactions on Computing Education (TOCE), 22(3), 1-40, 2022. https://doi.org/10.1145/3513140

6. Renò, V., Stella, E., Patruno, C., Capurso, A., Dimauro, G., Maglietta, R., Learning Analytics: Analysis of Methods for Online Assessment, Applied Sciences, 12(18):9296, 2022. https://doi.org/10.3390/app12189296

7. Omopariola, V. A., Ogbonna, C. N., Uloko, F., Abdullahi, M. J., Automated Assessment System Using Machine Learning Libraries, Open Journal for Information Technology, 6(2), 97-122, 2023. https://doi.org/10.32591/coas.ojit.0602.02097o

8. Chang, B., Student privacy issues in online learning environments, Distance Education, 42(1), 55-69, 2021. https://doi.org/10.1080/01587919.2020.1869527

9. Aria, M., Cuccurullo, C., bibliometrix: An R-tool for comprehensive science mapping analysis, Journal of Informetrics, 11(4), 959-975, 2017. https://doi.org/10.1016/j.joi.2017.08.007