Model for Assessing e-Learning Courses Considering Multiple Visual and Technical Indicators

M. Bankovska*, D. Borissova**, K. Rasheva-Yordanova*
* University of Library Studies and Information Technologies, Sofia, Bulgaria
** Institute of Information and Communication Technologies at the Bulgarian Academy of Sciences, Department of Information Processes and Decision Support Systems, 1113 Sofia, Bulgaria
m.bankovska@unibit.bg, daniela.borissova@iict.bas.bg, k.rasheva@unibit.bg

***Abstract* – The rapid progress of information and communication technologies and their penetration into the world of education has led to a gradual transition from conventional learning to modern e-learning. More and more universities and businesses have switched to web-based learning environments. Integrating electronic media into learning improves productivity by influencing both the effectiveness and efficiency of the learning process and the motivation of learners. This article aims to systematize the main indicators for evaluating e-learning media, considering multiple indicators. The identified important indicators are used to formulate a mathematical model for the overall assessment of the e-learning courses' performance. The proposed model could be applied to every e-learning course and is independent of the field of its application and the used learning environment. The obtained results demonstrate the applicability of the formulated mathematical model.**

Keywords – e-Learning; indicators for evaluation; ICT; mathematical model.

I. INTRODUCTION

The rapid progress of information and communication technologies and their entering the world of education leads to a gradual transition from conventional face-to-face learning to learning accessible through the use of digital media. In recent years, we have witnessed a trend towards an expanded use of learning web-based solutions by both schools, universities and businesses worldwide [15, 16, 24, 32, 37]. According to Guri-Rosenblit, e-learning is related to the use of electronic media for different learning proposals that can happen in the classroom environment and even replace the face-to face virtual meetings [32].

Using innovative approaches [8] and media as a communication environment for learning [22, 23] raises the interest of students in the learning process [26] creates a fruitful learning atmosphere, and stimulates students to acquire more knowledge in a shorter period of time. This on its part leads to raising the efficiency of the learning process. Consequently, according to some researchers [5, 25, 31] the use of instructional media is the most effective way to be used so that all learning objectives can be achieved.

In its broadest sense, e-learning media refers to anything that can be used to stimulate the thoughts, feelings, attention, abilities or skills of students so that it can promote the learning process in an electronic environment. According to Munawar, the application of e-learning media also leads to the improvement of learning competence [25]. A study conducted by Wahid revealed that the use of e-learning based learning media caused feelings of pleasure, quickly understood, and is more attractive than conventional learning media [3]. In addition, it is worth mentioning that an essential part of e-learning is represented by e-tests, which are also part of the educational process [9, 10, 17]. This means that when evaluating the overall performance of e-courses, e-tests have to be taken into account as an integral part of them [18].

The main aspiration of any educational institution offering e-learning should be aimed at automating learning and transferring knowledge to learners, while ensuring the effectiveness and efficiency of the educational process. Building an e-learning course, however, is an intersection of various competencies that a course designer should possess. In this regard, Michael Allen argues that design and development of good e-learning is a complex undertaking, and it requires content knowledge and expertise in a wide range of areas, including text composition, illustration, testing, instruction, interactivity design, user interface design, authoring or programming, and graphic design [21]. Not knowing or neglecting any of the mentioned elements can lead to deviations from the main goal of teaching and learning.

In order to be adequate to the needs of students, e-learning media should meet specific requirements. This, in turn, will ensure readiness to ensure the three characteristics: effectiveness, efficiency, and satisfaction with the learning process. It is extremely important to develop a mechanism for evaluating e-learning courses. Factors relevant to the above are: (1) technical and functional aspects of the educational platform used, (2) substantive aspects of the learning content, and (3) design approaches for its presentation. To assess all of these specific e-learning course requirements, a mathematical model based on multiple indicators needs to be formulated. This model should be applicable to any e-course and be independent of the area and field of application of e-learning media. Taking into account the formulated

problem, the current article aims to systematize the leading indicators for evaluating e-learning media and derive a generally applicable model for assessing e-learning courses.

The rest of the article is organized into several self-contained sections. Section II is focused builds a framework of metrics for evaluating e-learning systems, including various functional and technological requirements as well as constraints imposed by the design of the environment. In Section III a mathematical model based on the identified indicators for the assessment of e-courses is formulated. Section IV describes the results and analysis of conducted numerical testing of the proposed model, and the conclusions are drawn in Section V.

II. METRICS FOR ASSESSING E-LEARNING SYSTEMS

In our research, the most significant two groups of criteria for evaluating e-learning courses will be discussed namely: (1) visual performance and (2) technical performance. In the following lines, these two groups of criteria will be described along with as well as the evaluation indicators belonging to each of them.

A. Visual Indicators for Assessing e-Learning Courses

Evaluating the visual design in our research focuses on the evaluation of graphic design applied in e-learning media. Graphic design is important for conveying information in a clear and concise way, helping students learn more effectively and remember information better in a more engaging way. Imbalance and inconsistent use of colors, graphics, and typography, have all been found to reduce learning [2].

Based on Wynand et al. [4] we can claim that designing e-learning media is directly linked to the effective information exchange between the student and the educational platform, which directly affects the user's perceived experience of the e-learning environment [4]. A general rule is that the design should be tailored to the age group and educational needs of the learners, be as clean and simple as possible. It is often evaluated on user experience and usability.

A number of researchers have focused their research on the impact of graphic design on users, but few have addressed the evaluation of visual design and its impact on learning. According to Anglin et al. [14] the study of the effects of visual elements on learning is becoming important due to the increasing number of graphics used in educational materials. According to FAO [13] when conducting e-learning, the use of graphics (including illustrations, photos, diagrams and icons) is appropriate, as their use leads to the facilitation of learners.

Along with the use of graphics, by visual indicators we refer to the indicators of color, typography, graphics, contrast, as well as the compositional relations between them, creating harmony. Evans and Thomas [28] theorize that elements of visual design are line, texture, shape, space, which is why we add them to the analysis and evaluation factors. The arguments for the selection of these factors in our model can be found in the following:

- **Color** bring a clearer structure to the text, but also can be used as an aid that helps facilitate learning. Color can direct and hold the attention of learners.
- **Graphics** enhance many aspects of learning [30] including recognition, recall, comprehension and problem-solving. Graphics help to organize, interpret or transform textual information [11], which is of utmost importance for the learning process.
- **Lines** are used to add structure to a composition, to frame, and to separate information. In combination with text, lines can be used to highlight and emphasize a word, phrase or paragraph. In the context of e-learning media and the presentation of learning content, lines are particularly significant.
- **Visual texture** concerns some graphic techniques that draw attention to an element on the page or serve as a background to it. Texture is an essential element for any design, which is why we don't rule it out as a metric to be evaluated.
- **Shapes** are the basis of design, which on the other hand are the basis of every drawing, painting and graphic design [1]. Forms are three basic types – geometric, natural (or organic) and abstract ones. Regardless of which type they fall into, it is important to specify that shapes in e-learning media help separate and connect learning material in a visually appealing and organized way.
- **Space** in graphic design is the distance around the area between the different design elements involved in the composition. Space can be used to both separate and connect elements in visual design. Wider spaces separate elements from each other, and narrower spaces connect elements to reveal the connections between them. Overlapping elements maximizes their connection. The use of spaces in e-learning media will allow easier following of elements in the course, give visual space and create emphasis when needed.
- **Typography** is the art of arranging letters and text in a way that makes e-learning media legible, clear and visually appealing to learners. This includes elements such as font style, appearance, and structure.
- **Harmony** represents the balance between design decisions and design elements, and also the balance between typography and layout. The goal is that all elements of e-learning media design complement each other and form a harmonious relationship. According to Norman [7], designers must consider both cognitive and emotional aspects of design, as human cognition and emotion are closely related. All design elements have an influence in this direction at the same time.
- **Contrast** occurs in the juxtaposition of opposite elements – large versus small or dark versus light. Using contrast can highlight important design elements. Contrast is easily achieved with color, but can also be achieved with texture, type, and

graphic elements. An element brought to the fore and defined as primary by means of contrast is easier to find in the particular environment. This, in turn, facilitates the perception of information and its learning.

- **Composition** is used to direct the viewers [29]. Properly constructed composition affects the easy perception of visual design4 in e-learning environments. It refers to the overall organization of the fields – comparison of small to large elements, those grouped by common features and relating to a common theme, bringing to the fore the most important and significant objects for learning.

We can argue that the correct use of visual design indicators can lead to higher learning outcomes in the following several directions:

a) Attracting the attention of learners to a specific element of the content;

b) Creating analogies between new and existing content, respectively between information based on old and new knowledge;

c) Supporting the understanding of the basic concepts of the training course;

d) Motivating learners by working with more interesting and interactive materials.

Visual design evaluation indicators are directly related to technical indicators and will be discussed in the next section.

B. Technical Indicators for Assessing e-Learning Courses

Based on the fact that a web-based learning media platform is subject to evaluation, in the category of technical indicators, indicators such as: 1) code quality; 2) security; 3) speed; 4) usability; and 5) accessibility.

- When evaluating the **code quality**, it is necessary to carry out an analysis for the presence of errors or technical problems that interfere with the work with e-learning media. In short, an assessment of the internal quality of e-learning media is needed and in particular their adherence to good design principles. Quality can be represented as "totality of characteristics of an entity that bear on its ability to satisfy stated and implied needs" [19]. Adapting the results from the research by Kanellopoulos et al. [38] to this paper needs, when evaluating the code quality the following will be taken into account a) functionality, concerned with what the e-learning media does to fulfil students' needs; b) reliability, evaluating e-learning media's capability to maintain a specified level of performance; c) usability, assessing how understandable and usable the e-learning media is; d) efficiency, evaluating the capability of the e-learning media to exhibit the required performance with regards to the amount of learning resources needed; e) maintainability, concerned with the e-learning platform's capability to be modified; and f) portability, measuring the e-learning media's capability to be transferred across environments.

- **Security** indicator is essential with a view to securing personal data on the one hand and carrying out unauthorized breaches in the media on the other. An e-learning media vulnerability can be represented as a security flaw, problem or weakness found in software code that can be exploited by an attacker [20] to cause harm to the stakeholders of a e-learning platform [34]. It has been proven that for an application that is not reviewed for security flaws, there is a 100% probability of problems related to unregulated accesses and other breaches [27]. Therefore, we consider it of utmost importance that this indicator participates in our evaluation model. Availability of a suitable SSL certificate, use of secure access to site administration, use of an up-to-date CMS version (if available), etc. are evaluated.

- **Speed** is another indicator influencing the work with the system, which in turn directly affects the learning process. In terms of usability level, speed is one of the most fundamental characteristics [6, 12]. As a general rule, media and the related resources should work equally well at different Internet speeds, with requests being executed quickly and accurately. Factors such as having a CDN to serve the content or other type of optimization implementation are evaluated, as well as the overall loading speed of the resources.

- **Accessibility** indicator is an important indicator required by international web standards, referring to correctly developing and coding web-based platforms so disabled people can use them. According to W3C [36] accessible design improves overall user experience and satisfaction, in a variety of situations, across different devices. Accessibility ensures equal access to knowledge through educational media, which is why we include it in the list of indicators to be evaluated.

- **Usability** is another important indicator related to the extent to which e-learning media can be used by users to achieve educational goals with effectiveness, efficiency, and satisfaction. Availability for responsive design, availability of error visualization, search functionality and resource review are subject to evaluation; resource loading speed and last but not least – presence of intuitive structure and navigation [35]. Elements such as adaptability of content, changing navigation methods, readability of information and usability on touch devices should be monitored and evaluated here.

In conclusion, it can be argued that code inspection ensures the detection of vulnerabilities and flaws leading to delays in the execution of requests to and from the server side. Accessibility and usability are partially linked and depend both on other technical indicators and on some indicators of visual design. All of them are significant for the preparation of the summary evaluation of the technical indicator.

III. MODEL FOR ASSESSING E-LEARNING COURSES CONSIDERING MULTIPLE INDICATORS

The described above indicators could be used to assess different e-learning courses realized in various environments. To considers simultaneously all of these indicators, the following mathematical model is proposed:

$$C_q = \max\{\alpha \sum_i^v w_i^v e_{iv} + \beta \sum_j^t w_j^t e_{jt}\} \quad (1)$$

$$\alpha + \beta = 1 \quad (2)$$

$$\sum_i w_i^v = 1 \quad (3)$$

$$\sum_j w_j^t = 1 \quad (4)$$

where $q = \{1,2,\dots,Q\}$ represents set of e-learning courses, coefficient α expresses the importance of criterion related to visual performance while coefficient β expresses importance of criterion related to technical performance, the coefficients w_i^v and w_j^t express relative importance between indicators related to the visual and technical performance, e_{iv} and e_{jt} represents evaluations of *i-th* course about *v-th* criterion related to the visual performance, and corresponding *i-th* course about *t-th* criterion related to the technical performance.

IV. RESULTS ANALYSIS AND DISCUSSION

The proposed groups of criteria about visual and technical indicators along with mathematical model (1) – (4) could be used to assess different e-learning courses. In order to demonstrate the applicability of this approach, some preliminary tests have been done. A case study of two e-learning courses of basic of web programming is used to show the core idea of the described approach. In the assessment of these courses, four visual indicators and four technical were used as shown in Table I.

TABLE I. GROUPS OF CRITERIA AND INDICATORS FOR ASSESSING OF E-LEARNING COURSES

No	Criteria Groups		Indicators
1.	Visual performance	1.1	Composition and harmony
		1.2	Color
		1.3	Typography
		1.4	Contrast
2.	Technical performance	2.1	Security
		2.2	Usability
		2.3	Accessibility
		2.4	Speed

To be able to assess the overall performance of these e-learning courses based on the indicators in Table I, it is needed to determine coefficients for the relative importance between visual indicators and respectively between technical indicators. For the particular testing experiment, both visual and technical indicators are considered with equal importance with values $w_i^v = 0.25$ and $w_j^t = 0.25$. According to the formulated mathematical model (1) – (4), along with these coefficients, it is necessary to evaluate each e-learning course on all visual and technical indicators. These estimates and coefficients are summarized in Table II.

TABLE II. EVALUATIONS OF THE VISUAL AND TECHNICAL CHARACTERISTICS OF THE E-LEARNING COURSE

Groups of Criteria	Relative importance between indicators	Course-1	Course-2
Visual performance	$w_1^v = 0.25$	0.75	0.90
	$w_2^v = 0.25$	0.88	0.90
	$w_3^v = 0.25$	0.75	0.85
	$w_4^v = 0.25$	0.90	0.80
Technical performance	$w_1^t = 0.25$	0.90	0.88
	$w_2^t = 0.25$	0.85	0.87
	$w_3^t = 0.25$	0.95	0.85
	$w_4^t = 0.25$	0.88	0.85

The visual and technical performance evaluations are done using a scale from 0 to 1 where the bigger value means better performance of the evaluated criterion. Here should be mentioned that the proposed model could be integrated with other measurement approaches. For example, the Absolute Category Rating (ACR) method is used for quality tests. This method can be implemented using a five-point overall quality rating scale (*Bad, Poor, Fair, Good, Excellent*), which is the most widely used scale, or if required using a higher nine-point scale. Regardless of whether the five-point or the nine-point scale will be used, it is necessary to normalize the scores obtained in this way to the interval from 0 to 1. This is mandatory to provide dimensions similar to the other coefficients of the proposed model in order to obtain reliable results.

Last but not least, two additional coefficients related to visual and technical performance need to be determined. Two different cases are investigated using different values for the importance of visual and technical performance. Case-1 considers visual and technical performance with equal importance, while Case-2 gives more importance to technical performance indicators over visual ones. These two cases are shown in Table III.

TABLE III. VALUES OF COEFFICIENTS FOR VISUAL AND TECHNICAL CHARACTERISTICS IMPORTANCE

	Visual performance	Technical performance
Case-1	$\alpha = 0.5$	$\beta = 0.5$
Case-2	$\alpha = 0.4$	$\beta = 0.6$

The input data from Table II and Table III are used to verify the applicability of the proposed modeling approach (1) – (4) to assess the e-learning courses' performance according to the used visual and technical indicators. Obtained preliminary results of the conducted assessment of two similar e-learning courses are visualized in Fig. 1.

According to the results of Case-1 where equal values are used for the coefficients for visual and technical performance expressed by α and β ($\alpha = \beta = 0.5$) along with the equal importance between indicators of these two groups of indicators show that Course-1 has a better performance than Course-2. This is due to the obtained overall assessment equal to 0.8625 for Course-2 compared the value 0.8575 for overall assessment of Course-1 (see Fig. 1).

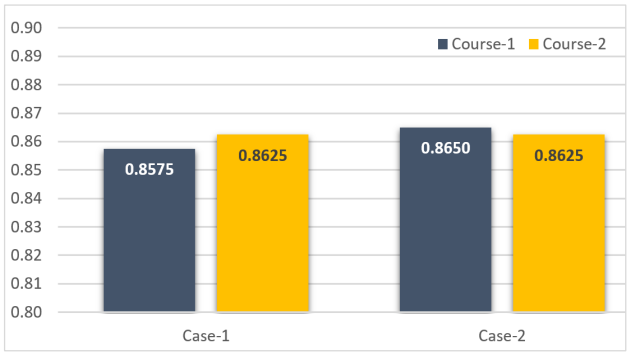

Figure 1. Assessment of e-learning courses using different importance values of visual and technical performance

The Case-2 simulates the situation where more attention is given to the technical indicators as a whole (see Table III). In this case, better performance is obtained for Course-1 with the overall assessment value equal to 0.8650 compared to the value of 0.8625 for Course-2 performance.

It is interesting to see how these courses are evaluated separately on visual and technical performance alone. This scenario is visually illustrated in Fig. 2.

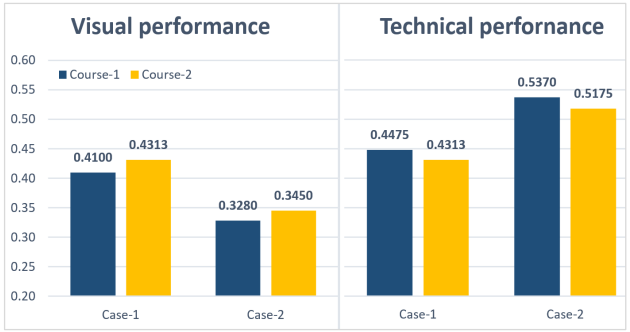

Figure 2. Cources assessment in respect to: a) visual performance; b) technical performance

Taking into account visual assessment separately from the technical one, it could be seen from Fig. 2 that the Course-2 has better visual performance compared to Course-1. Considering only the technical evaluation, it is easy to find that Course-1 has a better performance in both case: assessment of 0.4475 compared to Course-2 with value 0.4313 for case-1 and 0.5370 vs. 0.5175 for case-2 (see Fig. 2).

Although the visual parameters are better on Course-2 compared to Course-1 in both cases, and the technical parameters of Course-1 are better in both cases, the overall evaluation using the introduced coefficients α and β show different ranking for both cases (see Fig. 1).

It should be noted that the conducted preliminary tests do not consider situations where the coefficients w_i^v and w_j^t for relative importance between indicators for visual and technical performance differ. It is interesting to show how these similar sources will be performed when all identified indicators within this article are involved. These activities are planned as future investigations along with extending the proposed model for assessing e-learning courses by using additional indicators.

V. CONCLUSION

Digitization and related processes affect all areas of our lives, having a significant impact on e-learning. Along with these processes, the Covid-19 crisis has stimulated the transformation of various learning materials into e-learning courses. Therefore, the need to evaluate the offered electronic courses naturally arises. That is why the core idea of the current article aims to formulate a generally applicable mathematical model for the assessment of e-learning courses. The distinguishing characteristic of the proposed modeling approach is its independence of the area application of e-learning courses. The formulated model is capable to evaluate e-learning courses' performance taking into account simultaneously two types of criteria related to visual and technical indicators. It should be noted, that the proposed model uses of two types of coefficients to express: 1) the relative importance between visual and technical criteria, and 2) the relative importance between indicators that are part of visual and technical criteria. The conducted testing demonstrates the applicability of the proposed approach. The formulated mathematical model can be easily modified using additional indicators or a group of indicators. In this regard, it is interesting to involve an additional point of view namely the users' point of view. This evaluation composed of three groups of criteria is planned as future activities.

ACKNOWLEDGMENT

This work is supported by the Bulgarian National Science Fund through the project “Mathematical models, methods and algorithms for solving hard optimization problems to achieve high security in communications and better economic sustainability”, KP-06-H52/7/19-11-2021.

REFERENCES

[1] A. C. Bradshaw. Effects of Presentation Interference in Learning with Visuals. Journal of Visual Literacy, 23 (1), 41–68, 2003.

[2] A. E. Arntson. Graphic Design Basics. University of Wisconsin – Whitewater. Thomson Wadsworth, 2007.

[3] A. Wahid, Najiburrahman, K. Rahman et al. Effectiveness of Android-Based Mathematics Learning Media Application on Student Learning Achievement. Journal of Physics: Conference Series, 1–7, 2020. https://doi.org/10.1088/1742-6596/1594/1/012047.

[4] B. Wynand; H. Gelderblom, and A. van der Merwe. Why designers responsible for websites of large organisations disregard basic web design principles. CONF-IRM 2016 Proceedings. 4. http://aisel.aisnet.org/confirm2016/4.

[5] C. Muali, S. Minarti, M. Taufik Qurohman, Haimah. Analysis of metacognitive capability and student learning achievement through edmodo social network. Journal of Physics: Conference Series, 1175(1), 2019. https://doi.org/10.1088/1742-6596/1175/1/012150.

[6] C. Xilogianni, F. R. Doukas, I.C. Drivas, D. Kouis. Speed Matters: What to Prioritize in Optimization for Faster Websites. Analytics, 1, 175–192, 2022. https:// doi.org/10.3390/analytics1020012.

[7] D. A. Norman. Emotion & Design: Attractive things work better. Interactions Magazine, ix (4), 36–42, 2002.

[8] D. Borissova, D. Keremedchiev, G. Tuparov. Multi-criteria model for questions selection in generating e-education tests involving gamification. TEM J. Technol. Educ. Manag. Inform. 9(2), 779–785, 2020. https://doi.org/10.18421/TEM92-47.

[9] D. Borissova, N. Buhtiyarov, R. Yoshinov, M. Garvanova, I. Garvanov. Integrated Models-Driven Framework to Generate Various Online and Print Tests. In: Saeed, K., Dvorsky, J. (eds), Computer Information Systems and Industrial Management, LNCS, vol. 13293, pp. 316–329, (2022).

[10] D. Borissova, T. Ivanova, N. Buhtiarov, N. Naidenov, K. Rasheva-Yordanova, R. Yoshinov, M. Garvanova, I. Garvanov. Application of information technology in the teaching of mathematics when study of 2D geometric shapes. In: 45th Jubilee International Convention on Information, Communication and Electronic Technology (MIPRO 2022), pp. 638-643, 2022.

[11] D. Guo, S. Zhang, K. Landau Wright, and E. M. McTigue. Do You Get the Picture? A Meta-Analysis of the Effect of Graphics on Reading Comprehension. AERA Open, 2020.

[12] E. Fundingsland, J. Fike, J. Calvano, A. Raja, D. Lai, S. Silacci, S. He. Website usability analysis of United States emergency medicine residencies. AEM Educ. Train., 5, e10604, 2021.

[13] FAO. 2021. E-learning methodologies and good practices: A guide for designing and delivering e-learning solutions from the FAO elearning Academy, second edition. Rome. https://doi.org/10.4060/i2516e, ISBN 978-92-5-134401-9.

[14] G. J. Anglin, H. Vaez, and K. L. Cunningham. Visual Representations and Learning: The Role of Static and Animated Graphics. In D. H. Jonassen (Ed.), Handbook of research on educational communications and technology (pp. 865–916). Lawrence Erlbaum Associates Publishers, 2004.

[15] H. Amin, M. Shehata, S. Ahmed. Step-by-step guide to create competency-based assignments as an alternative for traditional summative assessment. MedEdPublish., 9(1):120, 2020.

[16] H. Djidu, S. Mashuri, N. Nasruddin, A. E. Sejati, Rasmuin, R., Ugi, L. E., and Arua, A. L. Online learning in the post-Covid-19 pandemic era: Is our higher education ready for it? Jurnal Penelitian Dan Pengkajian Ilmu Pendidikan: E-Saintika, 5(2), 139–151, 2021. https://doi.org/10.36312/esaintika.v5i2.479.

[17] I. Kostadinova, K. Rasheva-Yordanova, I. Ivanov, P. Petrova. Automated system for generating and validation a learning tests. In: ICERI2017 Proceedings, pp. 414–424, 2017.

[18] I. Mustakerov, and D. Borissova. A conceptual approach for development of educational Web-based e-testing system. Expert Systems with Applications, 38(11), 14060–14064, 2011. https://doi.org/10.1016/j.eswa.2011.04.214.

[19] ISO/IEC 9126. Software Engineering – Product Quality Int'l Standard, 2003.

[20] K. Dempsey, P. Eavy, and G. Moore. Automation Support for Security Control Assessments. Technical Report. Technical Report NISTIR 8011, National Institute of Standards and Technology, 2017.

[21] M. Allen. Michael Allen's guide to e-Learning (second edition): Building Interactive, Fun, and Effective Learning Programs for Any Company. Hoboken, USA, Wiley, 2016.

[22] M. Bali, Musrifah. The Problems of Application of Online Learning in the Affective and Psychomotor Domains During the Covid-19 Pandemic. Jurnal Pendidikan Agama Islam, 17(2), 137–154, 2020. https://doi.org/https://doi.org/10.14421/jpai.2020.172-03.

[23] M. H. Shehata, A.P. Kumar, M. R. Arekat, M. Alsenbesy, M. al Ansari A, Atwa H, et al. A toolbox for conducting an online OSCE. The Clinical Teacher, 18(3), 236–242, 2020. https://doi.org/10.1111/tct.13285.

[24] M. Muhammad Mushfi El Iq Bali, H. Baharun, A. Madanibillah, C. Muali et al. Innovative Learning Media Based on e-Learning in the New Normal Era. Proceedings of the 11th Annual International Conference on Industrial Engineering and Operations Management Singapore, March 7-11, 2021.

[25] M. Munawar. Supervisi Akademik: Mengurai Problematika Profesionalisme Guru di Sekolah. Al-Tanzim: Jurnal Manajemen Pendidikan Islam, 3(1), 135–155, 2019. https://doi.org/10.33650/al-tanzim.v3i1.522.

[26] N. Sudarwati, Rukminigsih. Evaluating E-Learning as a Learning Media: A Case of Entrepreneurship E-Learning Using Schoology as Media. International Journal of Emerging Technologies in Learning (iJET), 13(09), 269–279, 2018. https://doi.org/10.3991/ijet.v13i09.7783.

[27] OWASP Project. OWASP Code Review Guide 2.0 https://owasp.org/www-pdf-archive/OWASP_Code_Review_Guide_v2.pdf, 2017.

[28] P. Evans, M. Thomas. Exploring the elements of design (3rd ed.). Delmar, NY: Cengage Learning, 2013.

[29] R. E. Wileman. Visual Communicating. Englewood Cliffs, NJ: Educational Technology Publications, 1993.

[30] R. N. Carney, J. R. Levin. Pictorial illustrations still improve students' learning from text. Educational Psychology Review, 14(1), 5–26, 2002. https://doi.org/10.1023/A:1013176309260.

[31] S. Ahmed, M. Shehata, M. Hassanien. Emerging faculty needs for enhancing student engagement on a virtual platform. MedEdPublish, 9(1):75, 2020.

[32] S. Guri-Rosenblit 'Distance education' and 'e-learning': Not the same thing. Higher Education, 49(4), 467–493, 2005.

[33] S. Islam, H. Baharun, C. Muali, M. Ghufron, M. Bali, M. Wijaya, I. Marzuki. To Boost Students' Motivation and Achievement through Blended Learning. Journal of Physics: Conference Series, 1114(1), 1–11, 2018. https://doi.org/10.1088/1742-6596/1114/1/012046.

[34] The OWASP Foundation. OWASP Foundation. https: //owasp.org/, Last accessed December 2022.

[35] V. S. Moustakis, C. Litos, A. Dalivigas, L. Tsironis. Website Quality Assessment Criteria. Proceedings of the Ninth International Conference on Information Quality (ICIQ-04), pp. 59–73, 2004.

[36] W3C. Introduction to Web Accessibility. https://www.w3.org/WAI/fundamentals/accessibility-intro/, 2022.

[37] Y. B. Hermanto, and V. A. Srimulyani. The Challenges of Online Learning During the Covid-19 Pandemic. Jurnal Pendidikan Dan Pengajaran, 54(1), 46–57, 2021. https://doi.org/10.23887/jpp.v54i1.29703.

[38] Y. Kanellopoulos, P. Antonellis, D. Antoniou, C. Makris, E. Theodoridis, C. Tjortjis, N. Tsirakis. Code Quality Evaluation Methodology Using The ISO/IEC 9126 Standard. International Journal of Software Engineering & Applications (IJSEA), 1(3), 2010. http://dx.doi.org/10.5121/ijsea.2010.1302.

.