E-ISSN 2656-8039
INTERNATIONAL JOURNAL OF ENVIRONMENT, ENGINEERING & EDUCATION
www.ijeedu.com
Vol. 3, No. 1, 2021

Research Article

Application of E-Learning Based on Enriched Virtual Model in the Subject Database

Fitria[1], Ruslan[2], Muhammad Yusuf Mappeasse[2]

[1]Department of Vocational Technology Education, Universitas Negeri Makassar, Makassar 90222, Indonesia
[2]Department of Electronics Engineering, Universitas Negeri Makassar, Makassar 90224, Indonesia
Contact email: fitriafitri502@gmail.com, ruslan.ft@unm.ac.id, mappeasseyusuf@unm.ac.id

Received: *March 22, 2021;* ***Accepted:*** *April 20, 2021;* ***Published:*** *April 20, 2021*

Abstract: The study aims to discover the quality of e-learning based on Enriched Virtual model in database subject in the Computer and Informatics Engineering Study Program uses the ISO/IEC 25010 software quality metric method on the aspects of external quality and quality in use. The development model used in this study was adapted from Borg and Gall development model, consisting of 8 stages, namely, (1) Research and information collecting (initial research and information gathering), (2) Planning, (3) Develop preliminary form of product, (4) Preliminary field testing, (5) Main product revision, (6) Main field testing, (7) Final product revision, and (8) Final product. The subjects in this study were 74 students of Computer and Informatics Engineering Education Study Program. Data were collected through interview, observation, and questionnaire techniques. Data were analyzed using descriptive statistical analysis techniques and software quality metric methods ISO/IEC 25010. Based on the results of the study, e-learning based on Enriched Virtual model is produced in the database subject. The product developed has fulfilled all aspects of development. Media and material validation are in very good category, while the student's responses are in good category. The results of software quality testing using the quality metric method concludes that the final value of external quality is 0.45 and which is in medium category.

Keywords: Development, E-learning, Enriched Virtual Model, ISO/IEC 25010.

1. Introduction

Information technology continues to evolve every generation. Conventional media combined with new media has changed the pattern of media consumption and people's lives [1]. Almost everyone uses their mobile phone and email to support their daily activities [2]. Conventional media has entered new media, namely digital media and telecommunications networks that offer new lifestyles, create new jobs, and new social issues. One of the optimal information utilization sectors can provide innovative ideas for development [3], [4]. The development of science and technology further encourages reform efforts in the utilization of technological results in the learning process [5].

The effectiveness of learning is determined by many factors such as objective factors, teaching materials, methods, and learning media [6]. Learning is basically a communication process. Communication is the process of delivering a message from the sender of the message (communicator) to the recipient of the message (communion) through certain media. Based on this, the effectiveness of communication is determined by the four factors related in the communication process, namely communicators and communion. Communication is reviewed from the learning aspect of the communication process or interaction between teachers as communicators and students as communion. In the process, teachers send messages in the form of teaching materials or learning materials using certain media [7]. This means that the role

This Article Citation: *Fitria, Ruslan, M. Y. Mappeasse, "Application of E-Learning Based on Enriched Virtual Model in the Subject Database," Int. J. Environ. Eng. Educ., vol. 3, no. 1, pp. 32-40, 2021.*

of media in learning is very important in order to achieve the expected learning objectives [8].

Learning media is experiencing rapid evolution and development. The development of learning media has developed very well until now with the use of computer technology [9]. Computers have brought enormous changes in the field of education, especially educational technology. In addition to computer technology, the development of communication technology brings paradigm changes and learning practices. This is possible because communication technology can overcome distance and time [10].

The development of science and technology encourages efforts to encourage reform in the use of technological results in the learning process. The optimal use of information can provide innovative ideas for development [11]. The effectiveness of learning is determined by many factors, including the objective factor, teaching materials, learning methods and media [12]. Learning is basically a communication process. Communication is the process of delivering messages from message senders (communicators) to message recipients (communicants) through certain media [13]. Based on this, the effectiveness of communication is determined by the four factors involved in the communication process, namely the communicator and the communicant. Communication in terms of the learning aspect means the process of communication or interaction between the teacher as a communicator and the student as a communicant [14]. In this process the teacher sends messages in the form of teaching materials or learning materials using certain media. This means that the role of the media in learning is very important in order to achieve the expected learning objectives.

Learning that utilizes information and communication technology and software that allows online learning to take place creates a new method of learning, namely electronic learning (e-learning). According to Allen [15], e-learning is learning that is structured with the aim of using an electronic or computer system so that it is able to support the learning process. The learning system is used as a means for the teaching and learning process which is carried out without having to meet face to face directly between the teacher and the student [16]. The implementation of e-learning also continues to develop along with the development of learning theories and concepts. Several e-learning implementation models, including the Rotation Model, the flex model, the self-blended model and the enriched virtual model [17]–[19]. Enriched virtual model means at the same time. The learning process occurs at the same time between educators and students [20]. This allows direct interaction between educators and students with face-to-face or a picture of a real class using virtual and all students are connected via the internet. In implementation, the Enriched virtual model requires educators and students to access the internet simultaneously. Educators provide learning material in the form of papers or presentation slides and students can listen to presentations directly via the internet [20]. Students can also ask questions or comments directly or via the chat window.

Enriched virtual model is one of the smart learning class concepts. Smart learning classes can help teachers organize learning activities with the help of multimedia computer media [21]. The media is connected to the internet network to be able to run smart learning classes, so that the learning process can be combined between face-to-face learning (conventional class) and online. E-learning system developed can use collaborative learning method approach or learn from problem solving process that asks students to ask about something that is not yet understood, but here students are trained to learn critically and actively. E-learning system developed can use collaborative learning method approach or learn from problem-based learning process [22].

Based on the results of a preliminary study conducted through a questionnaire distributed to 28 students who had participated in the Database Course learning, it was concluded that: (1) 50% of students like face-to-face learning, 10.7% like learning using LMS, and 39.3% like blended learning (a combination of face-to-face and online learning); (2) 89.3% of students stated that the best LMS to use in database subjects is the Moodle LMS; (3) 82.1% of students stated that what video conferencing applications are most often used are Zoom Cloud Meeting, big blue button, and Google Meeting; (4) 96.4% of students stated that the video conferencing applications you like the most are Zoom Cloud Meeting, big blue button, and Google Meeting, (5) 71.4% of students stated that the synchronous learning model is the most preferred learning model, (6) 78.6% of students stated that the synchronous learning model is best used to achieve learning objectives, (7) 96.4% of students stated that the best learning model used in learning database subjects is Blended Learning.

During the Covid-19 pandemic, the Ministry of Education and Culture through the Directorate of Learning and Student Affairs has issued a guide for organizing learning in the Odd Semester 2021/2021 in universities. The guideline states that universities can organize online teaching and learning activities to minimize the risks and impacts caused by covid-19. Learning in online courses is carried out by: (1) self-study; (2) using digital teaching materials; (3) utilizing ICT-based learning media and (4) ICT-based learning interactions by minimizing direct interaction (on site) [23].

Based on the description above, it is very important to develop an online learning system that allows lecturers and students to interact directly. This is in line with the University's policy to maximize the use of online learning applications.

2. Research Methods

2.1. Models Research

The development model used in this study is a development model adapted from the Borg and Gall [24], development model. This model was chosen because this development model can overcome real needs in the here-and-now through the development of solutions to a problem and generate knowledge that can be used in the future. In addition, this model can produce a product/model that has a high validation value, because through a series of trials in the field and validated experts and able to encourage the process of product innovation is relentless so it is expected that there will always be found products that are always up to date with the demands of the latest.

2.2. Research Subjects

The subjects of this study were students in the Informatics and Computer Engineering Education Program, Faculty of Engineering, Makassar State University. The following are the subjects in this study.

Table 1. Research Subjects

No	Type of Trials	Number of Subject
1	One-on-one Trial	3 respondents
2	Small Group Trials	8 respondents
3	Main Field trials	33 respondents

2.3. Data Categories

In the trial phase, data is used as the basis for determining the effectiveness, efficiency, and attractiveness of the resulting product. Research data consists of quantitative and qualitative data. Quantitative data is collected using questionnaires. Qualitative data is collected through assessment results, inputs, suggestions obtained through questionnaires, interviews, and observations. The data revealed in this study are:

a. Validation of research instrument content through expert judgement.
b. Validation of material experts covering aspects of material feasibility, feasibility of presentation and contextualization.
c. Validation of media experts and learning design covering aspects of presentation techniques and feasibility of presentation.
d. Student responses during product trials that include aspects of display, presentation of materials and benefits.
e. Quality of e-learning development

2.4. Data Collection Instruments

The data collection instruments in this study are:

a. Interviews, used at the stage of identification, development, and trial of the product.
b. Observation, used in the identification, development, and trial phase of the product.
c. Questionnaires (questionnaires), used to collect data from validators and students at the stage of product development and trials.

Meanwhile, to obtain information about the validity and effectiveness of the resulting media, another instrument needs to be developed. The instruments are [25], [26]:

a. E-learning validation sheet is used to obtain enrich virtual model quality information based on validator assessment. On the validation sheet, the validator provides an assessment of e-learning based on the enrich virtual model developed. Validation will provide information on the feasibility of e-learning based and developed instruments.
b. Instrument grid; The questionnaire was compiled to measure the level of respondents' responses to e-learning based on enrich virtual models developed. Questionnaires are prepared to measure two main aspects, namely the display and content aspects. Furthermore, from these two aspects are prepared statements or questions used to measure the respondent's response to e-learning based on enrich virtual model developed.

2.5. Research and Development Steps

a. Preliminary Field Trials

Preliminary Field Trials was conducted to determine the quality of the software used and identify problems that arose at the time of the formation of the software quality factor. Testing was conducted using ISO/IEC 25010 software quality standards. The factors and sub-factors contained in the ISO/IEC 25010 model are only a few used for this study according to the characteristics of the software used. The following are the metrics that will be used in the ISO/IEC 25010 model.

Table 2. Metrics Criteria

No	Factors	Sub-Factor Metrics
1	Functionality Metrics	Accuracy Metrics

No	Factors	Sub-Factor Metrics
		Suitability Metrics
		Compliance Metrics
		Interoperability Metrics
2	Usability Metrics	Understandability Metrics
		Attractive Metric
		Operability Metrics
3	Efficiency Metrics	Time Behavior Metrics
		Time Behavior Metrics
4	Maintainability Metrics	Changeability Metrics
5	Portability Metrics	Replaceability Metrics
		Install Ability Metrics

Functionality, the software can provide the functions as per the needs of the user, when used under certain conditions. Functionality consists of four sub-characteristics, namely:

- Accuracy, this software can provide precise and correct results according to the needs.
- Suitability, the software can provide a set of functions suitable for specific tasks and user objectives.
- Compliance, the ability of the software to meet the standard needs in accordance with applicable regulations.
- Interoperability, the software can interact with one or more specific systems.

Usability, this software can be understood, learned, used, and interesting to the user, when used under certain conditions. Usability consists of three sub characteristics, namely:

- Understandability, the software is easy to understand.
- Attractive, the ability of the software in attracting users
- Operability, the software is easy to operate.

Efficiency, the software provides the appropriate performance and relative to the number of resources used at the time of such circumstances. Efficiency consists of one sub characteristic, namely; Time behavior software can provide appropriate response and processing time when performing its functions.

Maintainability is the ability of the software to be modified. Modifications include corrections, improvements or adaptations to environmental changes, requirements, and functional specifications. The sub characters on the Maintainability aspect used in this search are; changeability, the ability of the software to be modified in terms of appearance.

Portability is the ability for webinars to be transferred from one environment to another. Portability has two sub characteristics, namely:

- Replaceability, the ability of the software to be used instead of other software.
- Install ability is capable of being installed in different environments

2.6. Product Trials

Product trials in development are intended to collect data and information that will be used as the basis for establishing the effectiveness and attractiveness of the developed product. In this activity presented in sequence the trials conducted are one-on-one trials (individuals), small group testing and field trials (expanded trials). Citing the Covid-19 pandemic, product trials are only conducted through formative testing.

a. One-to-one testing

One-on-one trials or individual trials of initial product trials were conducted involving three research subjects who had different abilities, namely low, medium, and high. One-on-one trials aim to identify and correct deficiencies in early products and to obtain early performance indicators and student reactions to content. At this stage there are three aspects that are evaluated, namely: clarity of message, impact on students' attitude to learning and feasibility. The trial data is collected through questionnaires and then analyzed. The results of the data analysis in the one-on-one trial became input material to make initial product revisions.

b. Small group testing

Small group evaluation has two main objectives: to identify the effectiveness of changes made after one-to-one ciba tests and identify remaining learning problems that students may have. The small group trial involved eight randomly selected study subjects. The results of small group trials then become input material to revise the product.

c. Main field testing

Field trials refer to the evaluation of programs and products in the settings in which they are intended for use. Field trials aim to determine the effectiveness of changes in learning after a small group trial and to see if learning can be used in the context of real learning. The trial involved 33 research subjects. The results of field trials become materials to revise the final product.

3. Result and Discussions

The steps at this stage include: (1) conducting initial field tests on product design; (2) is limited, both the substance of the design and the parties involved. The data of the questionnaire results are then analyzed to determine the suitability of the product with a specific purpose to be achieved. The results of this trial are used as materials to revise the e-learning developed.

3.1. Preliminary Field Trials

Initial trials were conducted involving research subjects, namely students. The initial trial was conducted through two stages of trials, namely one-to-one testing involving 3 students.

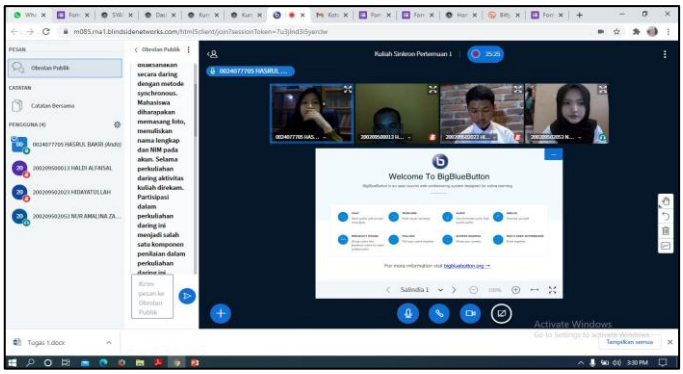

Figure 1. One-To-One Testing

Based on the table as many as 3 students or 100% assessed that e-learning development is in the category of very good. Compulsively the assessment of all students is in a positive category.

Table 3. Distribution of Frequency of Student Responses in One-To-One Testing

Intervals	Category	Freq.	Percentage (%)
>4.20	Excellent	3.00	100.00
3.40 – 4.20	Good	0.00	0.00
2.60 – 3.30	Good Enough	0.00	0.00
1.80 – 2.50	Less Good	0.00	0.00
<1.80	Very Not Good	0.00	0.00
	Total	3.00	100.00

3.2. Small Group Trials

Small group trials were conducted involving research subjects, namely students. The initial trial was conducted through two stages of trials, namely small group testing involving 8 students.

Figure 2. Small Group Testing

Based on the table of 1 student or 12.5% assessed that e-learning development is in the category of very good and 7 students or 87.5% assessed that e-learning development products are in the good category. Compulsively the assessment of all students is in a positive category.

Table 4. Distribution of Frequency of Student Responses in Small Group Testing

Intervals	Category	Freq.	Percentage (%)
>4.20	Excellent	1.00	12.50
3.40 – 4.20	Good	7.00	87.50
2.60 – 3.30	Good Enough	0.00	0.00
1.80 – 2.50	Less Good	0.00	0.00
<1.80	Very Not Good	0.00	0.00
	Total	8.00	100.00

3.3. Main Product Revision

Main product revisions are based on initial trial results. Information obtained both in the form of qualitative and quantitative information is used as a material to revise the product. Based on the results of limited trials that have been conducted it is known that there are still some things that need to be revised. In the one-on-one trials obtained results that the whole was in the good category. In small group trials obtained results that:

Table 5. Main product revisions

No.	Aspects	Revisions	Improvements
1	Display	Types of letters on media in e-learning based enriched virtual database course model	Changing the typeface on media in an enriched virtual-based e-learning database course model is easy to understand
2	Display	Sound quality when studying online on e-learning based enriched virtual database course model	Provide feedback to the manager to increase the band witch and server capacity
3	Interaction	Communication interaction between students is still lacking.	Add discussion and chat forum activity to each meeting.

3.4. Main Field Trials

Based on the consideration that face-to-face learning activities on campus are difficult to conduct empirical tests, product trials are only conducted by requesting student

responses to products that have been developed. The trial was conducted online using LMS Syam-OK..

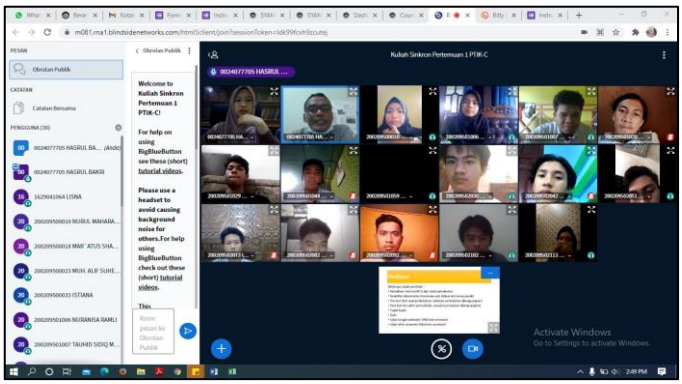

Figure 3. Main field testing

The trials were conducted during three meetings. After the meeting, students fill out a questionnaire of responses (responses) to products that have been developed. The process of filling out questionnaires is also done online using the Google Form application. Field trials were conducted on students of the Department of Informatics and Computer Engineering which amounted to 33 respondents

Table 6. Distribution of Frequency of Student Responses in Main field testing

Intervals	Category	Freq.	Percentage (%)
>4.20	Excellent	15.00	45.50
3.40 – 4.20	Good	18.00	54.50
2.60 – 3.30	Good Enough	0.00	0.00
1.80 – 2.50	Less Good	0.00	0.00
<1.80	Very Not Good	0.00	0.00
	Total	33.00	100.00

Based on table as many as 15 students or 45.5% assessed that the display aspect is in the category is very good and as many as 18 students or 54.5% assessed that the display aspect is in the good category. Compulsively the assessment of all students is in a positive category.

3.5. The Quality Metric Method

Testing software quality based on software quality standards ISO / IEC 25010 involved 74 respondents consisting of 69 students and 5 lecturers. Tests are carried out to assess external quality.

The assessment of the answers related to the Functionality factor is based on questions related to the functionality of the ISO / IEC 25010 metrics to the software. The overall assessment of the Functionality factor is by a weighting formula using the ROC method shown in the following table.

Table 7. Functionality

Sub Factor	Value
Accuracy	$W1 = \frac{1+\frac{1}{2}+\frac{1}{3}+\frac{1}{4}}{4} = 0.52$
Suitability	$W2 = \frac{0+\frac{1}{2}+\frac{1}{3}+\frac{1}{4}}{4} = 0.27$
Compliance	$W3 = \frac{0+0+\frac{1}{3}+\frac{1}{4}}{4} = 0.15$
Interoperability	$W4 = \frac{0+0+0+\frac{1}{4}}{4} = 0.06$

Value of Functionality = (0.35 * 0.52) + (07 * 0.27) + (0.50 * 0.15) + (0,56 * 0.06) = 0.18 + 0.19 + 0.08 + 0.03 = 0.48

Based on the value above, the aspect of Functionality with a value of 0.48, it is concluded that this video conferencing software is included in the medium category.

The answers to the answers related to the Usability factor are based on questions related to the Usability factor of the ISO/IEC 25010 video conferencing software metrics shown in the following table.

Table 8. Usability

Sub Factor	Value
Understandability	$W1 = \frac{1+\frac{1}{2}+\frac{1}{3}}{3} = 0.61$
Attractive	$W2 = \frac{1+\frac{1}{2}+\frac{1}{3}}{3} = 0.28$
Operability	$W3 = \frac{0+0+\frac{1}{3}}{3} = 0.11$

Value of Usability = (0.61 * 0.61) + (0.47 * 0.28) + (0.34 * 0.11)
= 0.37 + 0.13 + 0.037
= 0.54

From the value obtained is 0.54 which means this software is included in the medium category or sufficient in terms of usability.

The factor Efficiency assessment on the Time Behavior sub-factor metric used is the response time with the formula T = average time to get results from 74 respondents - The total time the command is completed is 10. The results of respondents' responses to time behavior obtained an average value of 5.27 so that T = 5.27 / 10 = 0.53. In terms of efficiency, because there are no other related sub-factors, the efficiency factor value is 0.53 or it is included in the medium category which means this software is quite efficient.

Maintainability factor assessment in the Changeability sub-sector matrix used Modification Complexity where the average number of successful changes divided by the

number of users tried. The average result of respondents' responses to the exchangeability factor is 2.14, then T = 2.14 / 10 = 0.21. Because there are no other related characteristics, the main ability factor value is 0.21. So, from the value obtained is 0.21 which means this software is included in the low category or less in terms of main ability. The results of the assessment of the portability factor responses are shown in the following table:

Table 9. Portability

Sub Factor	Value
Replaceability	$W1 = \frac{1+\frac{1}{2}+\frac{1}{3}}{3} = 0.61$
Instability	$W2 = \frac{0+0+\frac{1}{3}}{3} = 0.11$

Value of Portability = (0.82 * 0.61) + (0.49 * 0.11)
= 0.50 + 0.05
= 0,55

From the value obtained is 0.55 which means this software is included in the medium category or sufficient in terms of portability.

The final quality assessment is carried out by weighting all the performance values with the weights that have been determined by the ROC method as in the table Functionality has the most important role due to the number of related subfactors, namely 4 and followed by Usability 3 subfactors, Portability 3, Efficiency 1, and Main ability 1. If you have the same number of sub-factors, the weighting is calculated based on the number of linkages between the sub-factors and the software characteristics as in the following table:

Table 10. Calculation of the Final Value of External Quality

Factor	Value
Functionality	$W1 = \frac{1+\frac{1}{2}+\frac{1}{3}+\frac{1}{4}+\frac{1}{5}}{5} = 0.41$
Usability	$W2 = \frac{0+\frac{1}{2}+\frac{1}{3}+\frac{1}{4}+\frac{1}{5}}{5} = 0.21$
Portability	$W3 = \frac{0+0+\frac{1}{3}+\frac{1}{4}+\frac{1}{5}}{5} = 0.16$
Efficiency	$W4 = \frac{0+0+0+\frac{1}{4}+\frac{1}{5}}{5} = 0.09$
Main ability	$W5 = \frac{0+0+0+0+\frac{1}{5}}{5} = 0.04$

External Value = (0.48 * 0,41) + (0,54 * 0,21) + (0,55 * 0,16) + (0,53 * 0,09) + (0,21 * 0,04)
= 0,20 + 0,11 + 0,08 + 0,05 + 0,01
= 0.45

It can be concluded that from the final value of external quality, namely 0.45, it is included in the medium or sufficient category, which means that the quality of the software from an external point of view is sufficient.

The impact of the covid-19 pandemic has a huge impact on the management of the learning system. Learning that has been taking place in the classroom (real class room) turned into learning that takes place in a virtual class (virtual class room) the change should not reduce the quality and learning process, even should be a starting point in improving the quality of the process and learning outcomes. This can be achieved because e-learning has many advantages compared to conventional teaching and learning processes.

Assessment of the successful development of enriched E-learning based virtual model is done with various stages and methods. All stages and methods are directed to assess the validity and practicality of enriched E-learning based virtual model developed. Assessments are carried out repeatedly to obtain reliable development products. These aspects will then be explained in the description below.

3.6. The Validity

Validity means valid while validity is a measure that indicates the validity or completeness of an instrument. Validity must always be associated with empirical research and its evidence depends on the kind of validity used [27].

Aspects of validity tested in this study are the validity of the content and the validity of the construct. The validity of the content is determined based on the assessment and justification of the experts. The procedure taken for the instrument to be valid is to define the grid to be measured, determine the grid to be measured by each statement/question and compare each item with the specified grid. The instrument is said to have fulfilled the validity of the construct when the details of the statement/question that have been made meet the aspects of thinking as described in indicators [28], [29].

Based on the validation results of experts, the devices and instruments have all been declared valid, both in terms of content and constructs, meaning that the devices and instruments are declared valid and can be used in the next stage of research.

3.7. The Practicality

Practicality means being practical and efficient. Practicality relates to the ease and progress obtained by students in using enriched e-learning based virtual models that have been developed.

In development research, the model or media developed is said to be practical if experts and practitioners state that theoretically the model or media developed can be applied in the field and the level of

implementation of the model is in the minimum category either

In general, the definition of software quality put forward by is as an effective software process applied in a way that creates useful products that provide measurable value for those who produce them and those who use them. The process of making an item where we have to ascertain whether the goods are as expected or not, software development or software also demands the same[30], [31]. The methods used in analyzing the quality of the software are of course different compared to the methods used in factories for example. Testing is the process of executing the program intensively to find errors. Testing not only to get the program right, but also to ensure that it is error-free for all conditions. Software testing is a critical element of software quality assurance and presents specifications, designs and coding [32], [33].

In software engineering there are several models of software quality. In each of these models there are several factors that become the main points in the quality assessment of a software. The software quality model to be used in a software quality assessment is the ISO/IEC 25010 model. This model is part of the Software product Quality Requirements and Evaluation (SQuaRE), which is related to the software quality model that is the development of the previous model. In this model there are several additional sub-characteristics and some sub-characteristics that are transferred to other characteristics. The following are the characteristics or internal and external quality factors contained in the ISO/IEC 25010 model, the ISO/IEC 25010 model consists of two parts of the quality model for the quality of the software product, including: quality model, external metrics, internal metrics, quality in use model.

Based on the results of external quality assessment of LMS SYAM-OK UNM using software quality method based on ISO/IEC 25010 standard is in medium or satisfactory category. This means that LMS Sham-OK UNM has met all the quality criteria of the software especially about user satisfaction.

McConnell's Code Complete divides the software into two things: internal and external quality characteristics. External quality characteristics are part of a product that is related to the wearer, while the internal quality characteristics are not directly related to the wearer [34]. [34]. Software quality is defined as the expected conformity in all software built in terms of software functionality and software performance, documented software development standards and characteristics indicated by software [30].

Reality indicates that when utilized effectively, the utilization of information and communication technology can support high-level thinking skills by engaging learners in carrying out authentic and complex tasks in the context of collaborative learning [35], [36]. Furthermore, Soledad MacKinnon suggests that only a small percentage of technology applications (e.g., drills, exercises, tutorials) relate to directed instruction; most others (e.g., problem solving, multimedia applications, telecommunications) can improve not only targeted learning but also a constructive environment depending on how teachers integrate it into classroom learning activities [37].

Based on the results of user assessment research on quality in use aspects based on ISO/IEC 25010 standards are in the high category or very satisfactory. This means that LMS SYAM-OK UNM has met all the quality criteria of software usage.

4. Conclusion

The development produces e-learning based on an enriched virtual model in the database course of the Computer and Informatics Engineering Study Program, Makassar State University. The results of the media and material validity testing by two experts stated that the product developed was stated to be very good. Based on the results of trials on research subjects, it was stated that student responses to development products were in the good category. The results of testing the quality of e-learning based on the enriched virtual model based on the ISO/IEC 25010 standard are stated as follows: functionality factor with a value of 0.48 in the medium category or sufficient, the usability factor with a value of 0.54 in the medium category or sufficient, the efficiency factor with a value of 0.53 or entering into the medium category which means this software is quite efficient, main ability factor with a value of 0.21 which means this software is included in the low category, Portability factor with a value of 0.55 which means this software is included in the medium or sufficient category, the final value of external quality is 0.45 which is included in the medium category.

Acknowledgments

This research is supported by the Postgraduate Program, Universitas Negeri Makassar. Thanks to the Department Informatics and Computer Engineering, Universitas Negeri Makassar for the opportunity given until this research can be completed

References

[1] G. Marchionini, "Human–information interaction research and development," *Libr. Inf. Sci. Res.*, vol. 30, no. 3, pp. 165–174, 2008.

[2] T. X. Hammes, "Fourth generation warfare evolves, fifth emerges," *Mil. Rev.*, vol. 87, no. 3, p. 14, 2007.

[3] D. Holmes, *Communication theory: Media, technology and*

society. Sage, 2005.
[4] G. Goggin, G. Newell, and C. Newell, *Digital disability: The social construction of disability in new media*. Rowman & Littlefield, 2003.
[5] N. Gane and D. Beer, *New media: The key concepts*. Berg, 2008.
[6] Y. Lee, "An empirical investigation into factors influencing the adoption of an e-learning system," *Online Inf. Rev.*, 2006.
[7] R. Kern, "Perspectives on technology in learning and teaching languages," *Tesol Q.*, vol. 40, no. 1, pp. 183–210, 2006.
[8] A. Isman, "Instructional Design in Education: New Model.," *Turkish Online J. Educ. Technol.*, vol. 10, no. 1, pp. 136–142, 2011.
[9] D. Nix and R. J. Spiro, *Cognition, education, and multimedia: Exploring ideas in high technology*. Routledge, 1990.
[10] F. Belanger and D. H. Jordan, *Evaluation and Implementation of Distance Learning: Technologies, Tools and Techniques: Technologies, Tools and Techniques*. IGI Global, 1999.
[11] A. Hermanto, "Integration of EA and IT service to improve performance at higher education organizations," in *MATEC Web of Conferences*, 2018, vol. 154, p. 3008.
[12] Y. Ghilay, "Effectiveness of learning management systems in higher education: Views of Lecturers with different levels of activity in LMSs," *Ghilay, Y.(2019). Eff. Learn. Manag. Syst. High. Educ. Views Lect. with Differ. Levels Act. LMSs. J. Online High. Educ.*, vol. 3, no. 2, pp. 29–50, 2019.
[13] M. Akrim, "Media learning in digital era," in *2018 3rd International Conference on Education, Sports, Arts and Management Engineering (ICESAME 2018)*, 2018, pp. 458–460.
[14] R. Susanto, Y. A. Rozali, and N. Agustina, "Development of pedagogical competency models for elementary school teachers: Pedagogical knowledge, reflective ability, emotional intelligence and instructional communication pattern," *Univers. J. Educ. Res.*, vol. 7, no. 10, pp. 2032–2124, 2019.
[15] M. W. Allen, *Michael Allen's Guide to E-Learning: Building Interactive, Fun, and Effective Learning Programs for Any Company*. Wiley, 2013.
[16] D. R. Garrison, *E-Learning in the 21st Century: A Framework for Research and Practice*. Taylor & Francis, 2011.
[17] M. Armstrong-Hansche and N. MacQueen, *Workshop Rotation: A New Model for Sunday School*. Presbyterian Publishing Corporation, 2013.
[18] J. G. Cibulka and B. S. Cooper, *Technology in School Classrooms: How It Can Transform Teaching and Student Learning Today*. Rowman & Littlefield Publishers, 2017.
[19] M. Deepa, P. Reba, G. Santhanamari, and N. Susithra, "Enriched Blended Learning through Virtual Experience in Microprocessors and Microcontrollers Course," *J. Eng. Educ. Transform.*, vol. 34, pp. 642–650, 2021.
[20] M. B. Horn and H. Staker, *The Blended Workbook: Learning to Design the Schools of our Future*. Wiley, 2017.
[21] S. K. S. Cheung, R. Li, K. Phusavat, N. Paoprasert, and L. F. Kwok, *Blended Learning. Education in a Smart Learning Environment: 13th International Conference, ICBL 2020, Bangkok, Thailand, August 24–27, 2020, Proceedings*. Springer International Publishing, 2020.
[22] W. W. Lee and D. L. Owens, *Multimedia-based instructional design: computer-based training, web-based training, distance broadcast training, performance-based solutions*. John Wiley & Sons, 2004.
[23] Kemendikbud, *Panduan Penyelenggaraan Pembelajaran Semester Gasal 2020/2021 di Perguruan Tinggi*. 2020.
[24] M. D. Gall, W. R. Borg, and J. P. Gall, *Educational research: An introduction*. Longman Publishing, 1996.
[25] M. C. Bocarnea, *Online Instruments, Data Collection, and Electronic Measurements: Organizational Advancements: Organizational Advancements*. IGI Global, 2012.
[26] D. Colton and R. W. Covert, *Designing and constructing instruments for social research and evaluation*. John Wiley & Sons, 2007.
[27] J. A. Maxwell, "The validity and reliability of research: A realist perspective," *BERA/SAGE Handb. Educ. Res.*, vol. 1, pp. 116–141, 2017.
[28] S. Messick, "Standards of validity and the validity of standards in performance asessment," *Educ. Meas. Issues Pract.*, vol. 14, no. 4, pp. 5–8, 1995.
[29] S. Messick, "Validity of test interpretation and use.," 1990.
[30] I. O. for Standardization, *Systems and Software Engineering: Systems and Software Quality Requirements and Evaluation (SQuaRE): Measurement of System and Software Product Quality*. ISO, 2016.
[31] R. Pressman, "Software process impediment," *IEEE Softw.*, vol. 13, no. 5, pp. 16–17, 1996.
[32] A. Ginige and S. Murugesan, "Web engineering: An introduction," *IEEE Multimed.*, vol. 8, no. 1, pp. 14–18, 2001.
[33] X. Franch and J. P. Carvallo, "Using quality models in software package selection," *IEEE Softw.*, vol. 20, no. 1, pp. 34–41, 2003.
[34] S. McConnell, *Code complete: A practical handbook of software construction*, 2nd ed. Redmond, WA, USA.: Microsoft Press, 2004.
[35] M. J. Rosenberg and R. Foshay, "E-learning: Strategies for delivering knowledge in the digital age." Wiley Online Library, 2002.
[36] M. J. Rosenberg, *Beyond e-learning: Approaches and technologies to enhance organizational knowledge, learning, and performance*. John Wiley & Sons, 2005.
[37] S. MacKinnon, "Technology Integration in the Classroom Is There Only One Way to Make It Effective?," 2002.