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Research paper



A Systematic Review of Formative Assessment Tools in the Blended Learning Environment

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Abstract

An effective method of student assessment technique is necessary for assessing student knowledge. Nowadays, the utilization of formative assessment tools in blended learning is increasing because it can enhance the learning quality. The main aim of this study to identify and classify existing research through the research approach, assessment tools type, and assessment specialty on formative assessment tools in a blended learning environment. This study guiding the educators in choosing and developing new assessment tools. The methodology of this research using a systematic review. This method using the inclusion and exclusion process to make a systematic review focused and choose appropriate studies. The result shows that the highest usage of assessment tool type is automatic assessment with the percentage of 87%. Semi-Automatic assessment has 13% and manual assessment 0%. It proves that technology is an important part of education and teaching because significantly transform the method of assessment from manual to automatic assessment type. This is a great transformation from the traditional method to the modern method of assessment. We recommend to further improve methods for online formative assessment and develop computer-based testing in a blended learning environment for future work.

Keywords: *Formative assessment; Blended Learning; Assessment Tools; Systematic Review.*

1. Introduction

Blended learning is the combinations of direct learning in class and e-learning by online in formal education [1]. The concept of blended learning is synchronous (Place and time limited by dependent physical evidence) and asynchronous (Flexible place anywhere and anytime) learning activities [2]. The usage of blended learning is growing in higher education around the world. Past experiment studies area of Moscow State University in Russia proved that blended learning is an effective education system [3]. According to at the University of Central Florida, blended learning can bring positive institutional change transformation [4]. The blended learning able to switchover learning activity from passive to active, provide two type of teaching style in class and by online, more flexible and efficient course [5].

Formative assessment measuring the achievement of student understanding and providing student's feedback [6]. The purpose of summative assessment is for grading and to verify the achievement of an academic goal. Grading is dissension because pursuing grades can distract from profound learning [7]. The primary purposes of formative assessment in providing information about students' learning and providing feedback about their progress in learning objectives [8]. Adapting a blended course requires to modify the assessments accordingly to support the blended learning process and provide student's feedback immediately [9, 10].

The aim of this study to identify and classify formative assessment tools in a blended learning environment. This study is guiding the educators in choosing and developing new assessment tools.

The definition of the assessment tool is a tool to help the educators to assess students assignments [11]. When the number of students is increasing, it able to work automatically by online or offline without taking much time like performed manually. The assessment tools provide immediate feedback, support student's assignment and motivate them to obtain the better learning outcome. The utilization of assessment tools is increasing because it can enhance the learning quality [12]. Assessment tools support immediate feedback, it helps teachers or lectures to deliver the result to students. The assessment tools working through systematically and the result is more consistent and easy to use [13].

Nowadays, the educators learn more about integrating technology for e-learning courses in the blended learning process to interest and motivate students in learning. Other research does not provide a view of the formative assessment tools in a blended learning environment based on the research approach, assessment tools type, and assessment specialty [14–16]. Thus, this study contributes to guiding the educators to choose and new develop formative assessment tool in the blended learning environment.

In [17] shows that students very enjoyable and suitable for blended learning. The students of today accept new technology rapidly and learn easily to handle it.

The overview of the concept blended learning from [18] suggest that need more support for instructors who adopt the new mode of teaching. Blended learning is not a new issue but the tools available to us today are new. Therefore, the academicians should focus on the usage of the technology in adopting blended learning because facilitating students' learning processes is the key challenges to design blended learning [19, 20].

Tutor-mediated support is a key element of blended learning and it is able to provide the more effective use of technology [21]. Blended learning is students focused activity which is request change of a conventional teacher into a tutor and facilitator or mentor but not a direct source of knowledge and information. In [22] proved that improvement in the achievement of required

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learning goals' can be influenced on the level of learning goals achieved by announcing and conducting appropriate types of online assessments. Assessment activities and the feedback have a positive impact on the process of learning [23].

Blended learning combines traditional learning and e-learning. The e-learning content is consist of the online activities and exercises aspect, such as online tests, posted on the learning platform, to check the comprehension of the content [24]. The highest effective tools for the blended learning process are online chatting like email, online exercises, and video [25]. The previous study proves that the performance of students is better when using a computer-based test (CBT) or online assessment than using paper-based assessment [26].

In [27] recommend software as formative assessment tools for creating electronic tests because it allows an individual combination of questions. Testing and evaluation process need apply electronic tools to saving time significantly and help the educators in continuous evaluation to improve the quality of the teaching process. The researchers need the actual effectiveness e-assessment of blended learning to support Formative Assessment in real classrooms [28].

Based on related to the previous study, we can conclude that assessment as an important part of teaching to improve student achievement and engagement in blended learning. The facilitation of assessment tools in a learning process with some feature needs to increase student motivation. This was evident by the benefits obtained by previous users. Then, the tools or software can be assisted in the learning process, especially in making the questions to the students, in order avoided boredom and increased motivation and interest of students in the lecture.

2. Methodology

We used a systematic review as the research method to conduct this study. This method follows the guidelines proposed by [29]. The aim of a systematic review to examine all relevant evidence that suit with the qualification criteria to answer a particular research question. The key characteristics of a systematic review are; (a) a clear set of objectives, (b) a systematic search to identify all studies, (c) characteristics of the included studies.

It described with a flow diagram as showed in Fig. 2. This method has four phases, there are identification, screening process, eligibility, and inclusion. This method used inclusion and exclusion or selection and deselection process to make a systematic review focused and choose appropriate studies [20]. The flow diagram in Fig. 2 shows the article selection process, we select 422 studies after detect 5 duplicates papers. Finally, a total of studies include after full-text screening is 17 related papers following inclusion criteria. Afterward, we exclude 2 papers based on eligibility and the main focus of these papers. So, we have 15 total selected studies.

SLR is selected as the research method to conduct this study. The SLR method is aimed to evaluate all the existing studies that are relevant to the specific topic area in order to present a fair evaluation of a research topic by using a trustworthy, rigorous, and auditable methodology [36]. The research methodology to conduct the SLR was based on the standard SLR guidelines proposed by [36]. Fig. 2 shows the research review protocol we have adopted which consists of seven phases: research questions; search process strategy; selection criteria including inclusion, exclusion, and quality assessment criterion; document retrieval; data collection; data synthesis; and obtained result.

2.1 Information Sources

We get research papers from three sources of databases, there are ScienceDirect, IEEE Xplore digital library, and Web of Science (WOS). The selection process of papers based on complex search query, categories of papers, the main focus of papers and particularly tracks various conference journal in education, computer science, and information technology.

2.2 Literature Search Strategy

We used the query in advance search which is following search terms: ("assessment method" OR "assessment tools" OR "online assessment" OR "formative assessment" OR "online formative assessment" OR "e-assessment") AND ("blended learning" OR "blended teaching" OR "hybrid learning" OR "hybrid teaching"). In addition, results were refined by categorizing i.e. limited year range in 2012 to 2018 and type of document only journal with full text, conference papers with the English language as shown in Fig. 1.

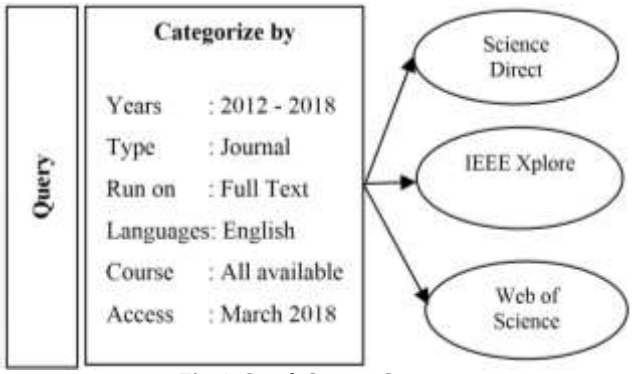

Fig. 1: Search Strategy Settings

2.3 Eligibility Criteria

First, the authors remove duplicate papers and select relevant studies by judging title. Then, we selected based on abstract and conclusion, the following inclusion criteria were applied: (a) the aim of studies had to design or improve or development of formative assessment process in learning activity, (b) the studies had to be done at course level or within units of a course in educational context, (c) the studies had result or findings. The selected criteria by full text were set as follows: (a) the papers which conducted in the blended learning process, (b) the studies at least used one specific assessment tool, (c) the studies had a clear methodology.

2.4 Classification

The authors classify the selected studies in three dimensions. The first is classification by research approach, second is classification by assessment tools type, and third is classification by assessment specialty. Each of the three dimensions consisted of several categories. The categories of research approaches are; (a) quantitative approach, (b) qualitative approach, and (c) mix method approach [30]. The categories of assessment tools type are; (a) manual assessment tools, (b) semi-automatic assessment tools, (c) automatic assessment tools [11]. The categories of assessment specialty are; (a) tools specialized in software testing, (b) tools specialized in a quiz, and (c) tools specialized in computer based-test [14]. The explanation of each category will describe more in detail in the discussion part.

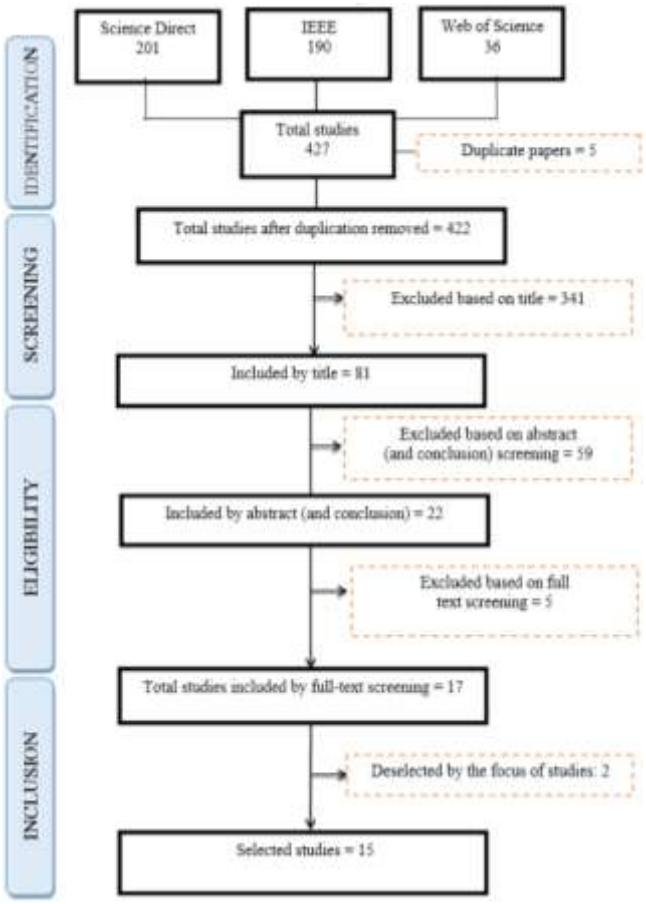

Fig. 2: Flow diagram of the article selection process

3. Discussion

Fig. 3 gives the information about how many papers are selected after insert the query. It shows a total of papers was collected from the literature. That papers are in the full text. There are 427 studies from databases with details 201 papers from ScienceDirect, 190 papers from IEEE Explore, and 36 papers from Web of Science.

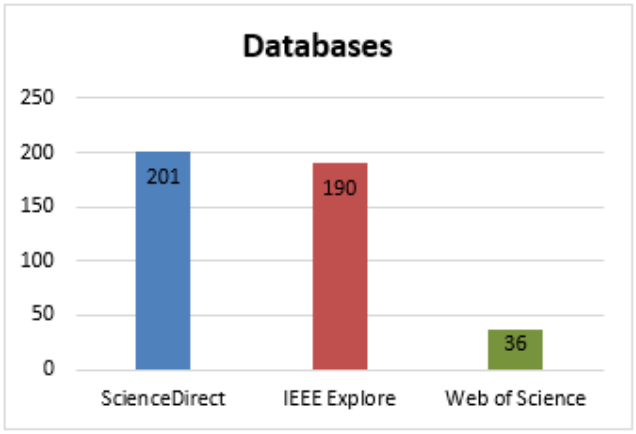

Fig. 3: Number of papers by the query

We choose articles which include in the final selection process. In this way, we recognized to identify 15 articles from 3 sources. Fig. 4 shows the country of the author's. We consider taking the country of the main author in multiple author's case. Majority of the research about formative assessment tool in blended learning were in Spain country in range time 2012-2018. The other country from Australia, Netherlands, Slovak Republic, South Africa, Malaysia, Croatia, China, United States, and the Republic of Macedonia.

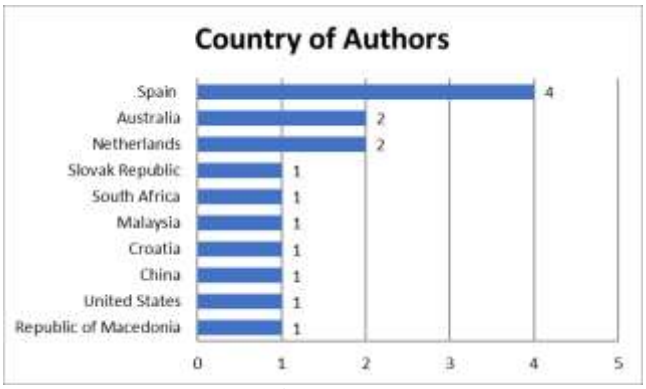

Fig. 4: Number of selected papers by country

3.1 Research Approach

This study aims to update the information about formative assessment tools that can be used in a blended learning approach nowadays. Fig. 5 illustrates the number of papers by research type and publication year. The categories of research approaches are (a) qualitative research, (b) quantitative research, (c) mix approach. Research approaches is the plans and the procedures for research that cover the steps from general assumptions to detailed methods of data collection, analysis, and interpretation. There are seven quantitative research, four qualitative research, and four mix method research. Based on that, the most research approach from the selected articles in the range year 2012-2018 is quantitative research.

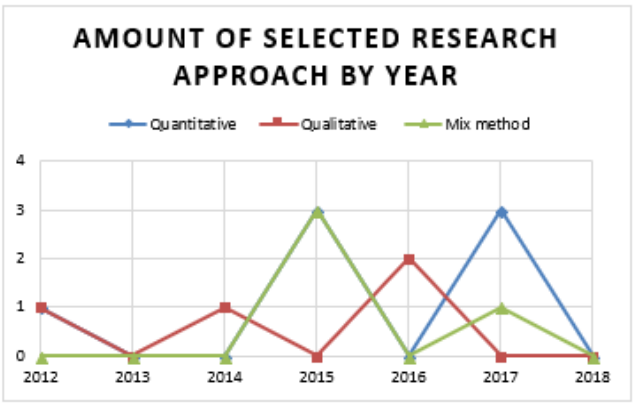

Fig. 5: Type of research by year

A quantitative approach is an approach which examines the relationship among variables of objective theories [31]. We can use an instrument to measure the variables. A quantitative approach employs strategies of inquiry such as experiments, surveys and collects data on predetermined instruments. We can use statistical procedures to analyze the numeric data type. The final report of the quantitative approach has a set structure consisting of introduction, literature, and theory, methods, results, and discussion.

We can define a qualitative approach as an approach to investigate and understand the meaning of social or human problem from individuals or groups [31]. The purpose of a qualitative approach is to investigate the nature of phenomena by using a method of interviews, observation, and written documents. The design research which includes qualitative data is sketches, arguments, and decisions, gestures, designer, opinions, etc. The process of this approach involves research questions and procedure, data collected, data analysis, and data interpretation.

Mixed methods approach is an approach to an inquiry involving collecting both quantitative and qualitative data [32]. This approach using different designs that could involve philosophical assumptions and theoretical frameworks to integrates the two types of data. Table 1 shows the main idea of the mix method

approach, which combines qualitative and quantitative approaches. The final database from data collection of mixed methods approach represents both quantitative and qualitative information by involves both numeric information and text information.

Table 1: Comparative of research approaches

Category	Quantitative	Qualitative	Mix Methods
Research objectives	Description, explanation, and prediction	Discovery and exploration	Multiple objectives
Data sources	Performance, attitude, and observational	Interview, observations, and audio-visual	Multiple forms
Data analysis	Statistical analysis of numeric data	Narrative description and interpretation	Statistical and narrative analysis

Table 2 shows the classification of selected papers based on authors and year, research approach, grade, and country. We present a precise of the contexts of the papers and coded all of the selected studies. The research code of P1 was conducted in Grade three primary school and P8 was conducted in 2-grade secondary school classes. The others studies were conducted at the university.

From 15 of primary studies has been selected, (P1, P2, P3, P8, P9, P10, and P14) are quantitative research, (P5, P6, P13, and P15) are qualitative research, and (P4, P7, P11, P12) are mix method research.

This is some point of view about formative assessment tools in blended learning from previous studies. In [12] use random experimental design to examine the effects of a digital formative assessment tool on mathematics achievement and motivation. The findings of this study indicate that a digital formative assessment tool can have a positive impact on the mathematics achievement of students.

In [28] conduct research using a digital formative assessment tool when control schools use their regular teaching methods and materials. The tool provides student feedback and adaptive assignments. This study found that Be-A functionalities are behaving as a very appropriate platform for the development of these ideas. The recommendation needs to research the actual effectiveness of this new development in real classrooms.

In [27] improved the evaluation process in mathematics by using Wonder share quiz creator software. This study compares student's outcomes by using electronic test and student's outcomes by using pencil and paper as the old method system. The finding of this study shows that electronic test very useful to students and educators because of more saving time, allows educators to check automatically, and improve the quality of the teaching process. The researchers suggest to all the mathematics teachers to create electronic tests using Wonder share quiz Creator software.

In [37] conduct study to examine the effect of computer-based formative assessment feedback in the context of searching for information online. Computer-based formative assessment in the learning environments can be developed with a predicting of student performance. The recommendation from the authors for the next research to examine about the quality of solutions to information problems and improve student performance by student-specific feedback based on logged information seeking behavior.

In [43] doing research on how the setting feature of formative assessment can customize to better serve the formative purpose in e-assessment is limited. We can use this research as a reference to other institutions, lecturers, and students to adopt online assessment as a self-test quiz tool in the learner and assessment-center learning environments.

Table 2: Classification of articles by research types, grade, and country

Code	References	Research Approach	Grade	Country
P1	[12]	Quantitative	Grade three primary school	Netherlands
P2	[33]	Quantitative	High Education, Campbell University College of Pharmacy and Health Sciences (CPHS)	United States
P3	[34]	Quantitative	High Education, Universitat Oberta de Catalunya (UOC)	Spain
P4	[35]	Mix method	Central China Normal University	China
P5	[28]	Qualitative	High Education, University of Vigo	Spain
P6	[36]	Qualitative	University of Technology Sydney (UTS)	Australia
P7	[27]	Mix method	High Education	Republic of Macedonia
P8	[37]	Quantitative	2-grade secondary school classes	Netherlands
P9	[38]	Quantitative	High Education, University of Rijeka	Croatia
P10	[39]	Quantitative	First and Second Year Program in Technical University of Valencia (UPV)	Spain
P11	[40]	Mix method	High Education, University of Adelaide	Australia
P12	[41]	Mix method	High Education, Walter Sisulu University	South Africa
P13	[42]	Qualitative	High Education, University of Santiago de Compostela	Spain
P14	[43]	Quantitative	The second trimester of the 2011/2012 academic year in Multimedia University	Malaysia
P15	[44]	Qualitative	Travana University	Slovak Republic

3.2 Assessment Tools Type

Based on the previous study from [14] suggest three categories of assessment tools type. The categories of assessment tools type are manual assessment, semi-automatic assessment, and automatic assessment. In Fig. 6, we can see the highest assessment type is automatic assessment with the percentage of 87%. Semi-Automatic assessment has 13% and manual assessment 0%. From literature, only 2 study which develops the semi-automatic assessment.

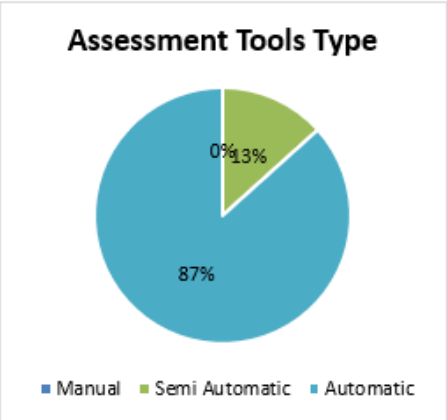

Fig. 6: Circle diagram of assessment tools type

The manual assessment tool helps the educators to assess a student's project. In addition, the appraisal performance manually.
It works manually graded by teachers or lectures. The semi-automatic assessment tools as automatically check and also manually check the assessment [45]. It still needs manual inspection. The educators need to check manually to know the differences between the output and the expected output of that tools. Whereas, it able to assess automatically with online or offline by using automatic assessment tools. It can be called online assessment if connected internet. The recent study review concludes that online formative assessment rectifies learner engagement. Online formative assessment can provide a response immediately to the students and have positive effects on learning and improve the quality of the teaching process [16, 46].
In assessing student knowledge require student assessment technique as an effective method. Information and communication technology (ICT) has become an important part of education and teaching as well because the method of assessment transform significantly from manual to automatic and from paper-pencil test (PPT) to computer-based test (CBT) [26]. There is a great transformation from the conventional method of assessment to the modern method.
Table 3 shows the classification of primary studies by subject, software usage, assessment tools type, and assessment specialty. Most of those choose mathematics and engineering subject in their research. The authors use a software as formative assessment tools in the blended learning environment such as Exam Soft®, Soft Learn, SPARK^{plus} software, Wiris-quizzes, MATHEMATICA software, and Wonder share quiz creator software. The result shows that there is no manual assessment research that we found. Only two research, which includes in semi-automatic assessment (P5 and P11). Other research used automatic assessment tools.

Table 3:. Classification of articles by subject, tools, assessment tools type, and specialty

Code	Subject	Tools	Assessment Tools Type	Specialty
P1	Mathematics	The Digital Formative Assessment Tool: Snappet	Automatic	Software Testing
P2	Courses in the CPHS pharmacy	Used ExamSoft®	Automatic	Computer Based-Test
P3	Mathematical analysis	Wiris-quizzes	Automatic	Quizzes
P4	Software engineering	Hstar teaching platform	Automatic	Computer Based-Test
P5	Math subject	Be-A (Web platform used in the University of Vigo that provides assessment functionalities)	Semi-Automatic	Quizzes
P6	Sciences	SPARK^{plus} software	Automatic	Software Testing
P7	System Linear Equation	Wondershare QuizCreator software	Automatic	Software Testing
P8	History lessons	Digital Information Skills Measurement instrument (DIM)	Automatic	Computer Based-Test
P9	Information and System	MudRi, a version of Moodle LMS	Automatic	Quizzes
P10	Math in Aerospace Engineering	MATHEMATICA software	Automatic	Software Testing
P11	Governance and Sustainable Development in the Social Sciences	Flexible assessment	Semi-Automatic	None specialized
P12	Engineering and Technology	VLE platform	Automatic	Computer Based-Test
P13	Educational Technology	SoftLearn	Automatic	Software Testing
P14	Mathematics	Adopted MyMathLab (MML) system to be used as a self-test quiz tool	Automatic	Quizzes
P15	Arithmatic in Mathematical	Wondershare QuizCreator software	Automatic	Software Testing

3.3 Assessment specialty

The assessment specialty based on software testing is the utilization of one or more software as tools in the assessment process and focus on to test software performance. Software testing is an expansion of the software development process. The definition of software testing is technical investigation of the software to get information about the quality from stakeholders' point of view.
The definition of assessment tools based on quizzes is tools whose focus on how to create a question for a quiz in quiz management system (QMS). Students can access the quiz online or offline. The various quizzes type is true or False, Multiple Choice (Single Answer), Multiple Response (Multiple Answers), Fill in the Blank, Matching, Sequence, Word Bank, Click Map, Short Essay, etc.
The assessment tools based on computer based-test are tools which focus on developing an application to assess student progress. Computer-based test (CBT) is a technology using a computer to manage the test and the devices connect to the internet [26]. Computer-based test (CBT) provides assessment interface that can be able to allow students input the answers and receive feedback using a computer.
Most of the tools have a specialty in software testing. There are six paper focus on software testing (P1, P6, P7, P13, and P15), in the other hands four papers (P2, P4, P8, and P12) focus on computer based-test, four papers focus on quizzes (P3, P5, P9, P14) and there is no specialized in one paper (P1). We also highlight that will not identify any tool which has more one specialty, although the assessment tools enable to have two or more specialties.

4. Conclusion

This review informs the current usage of formative assessment tools in blended learning and also guiding the educators in choosing appropriate assessment type and give future directions for developing a new assessment tool. After identify and classify assessment tool through the research approach, assessment tools type, and assessment specialty, we can conclude that the highest usage of assessment type is automatic assessment with the percentage of 87%. Semi-Automatic assessment has 13% and manual assessment 0%. It proved that technology has become an important part of education and teaching as well because has significantly transformed the method of assessment from manual to automatic assessment type. There is a great transformation from the conventional method of assessment to the modern method. The automatic assessment more flexible and provide timely and prompt feedback to the students. It saving more time and reducing effort spent by instructors in the assessment process.
The usage of internet as information technologies for education allows the educators to create interactive test as tools to motivate students in a learning process and check their progress automatically. An interactive feedback in online formative assessment is important characteristics to increase student's focus through student engagement and learning experiences. Such as Blended electronic assessment (BeA) provide Self-Regulated Learning to support formative assessment. These tools enable the educators to deep analyze mistakes and to group students based on that mistake. Computer-based test as a formative assessment tool in the blended learning environments can be developed with a predicting of stu-

dent performance. It offers the advantages than traditional paper-based. The advantages of a computer-based test are, provide immediate feedback to student, place and time more flexible to carry out the exam, more interactive. We recommend the researcher for future study to improve automatic formative assessment tools by online in blended learning environment. It can use computer-based testing because able to check the level of their knowledge automatically and give the feedback immediately to support the educators in the modernization and automation of the assessment process.

Acknowledgment

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