Why are mathematics teachers advised to use blended learning in the learning process?

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Abstract. The success of mathematics learning is strongly influenced by the initiative and strong ability of educators to implement the learning that supports the achievement of the goals of mathematics learning. An effort to help provide an overview to the teacher to find a solution in choosing a learning model that can be applied in mathematics learning, this research was conducted. Focusing on the results of implementing blended learning in all possible learning programs with varying levels of education, 11 relevant articles were obtained to answer the formulation of this problem. The results obtained that the use of blended learning is very possible in mathematics learning. This is based on the results of research relating to the implementation of blended learning which has the potential to improve learning outcomes, activity, interest, motivation, understanding and even provides space for communication skills, teamwork, independence, and student achievement.

1. Introduction
Learning purpose is not to train students' ability to memorize facts and problem solving procedures. Moreover, the purpose of learning is to guide students to understand the concept in order to be able apply concepts in life. To achieve learning outcomes that match expectations and overcome the decline in student learning achievement, the changes in policies and standards in mathematics are some possible solutions to overcome the decline in student achievement in mathematics [1]. These policies and standards can be in the form of developing curriculum and core mathematics standards. The National Mathematics Teachers Council (NCTM) reformed efforts to improve student achievement in mathematics through revising curriculum and core mathematics standards. The revision process is primarily focused on thorough and deeper pedagogical content knowledge from conceptual understanding [2]. Not only working with curriculum and core mathematics standards, but also the effectiveness of teaching approaches and metacognitive strategies, which aims to improve and design mastery of abstract concepts in mathematics is also another problem in achieving success in the mathematics learning [3].

Providing opportunities to explore and practice more deeply about a concept can support student abilities to understand concepts better because conceptual understanding cannot be transferred by the teacher to students, but must be built and formed by students under the guidance of the teacher, and on the basis of prior knowledge and experience. It is same as the learning perspective, "learning is the process of understanding the world and negotiating with others to resolve uncertainties and to achieve an understanding of one's opinion [4]. In addition, scaffolding from the teacher and intensive discussions between students that occur in the learning process can help students understanding. According to Magiera and Zawojewski, the lack of meaningful mathematical discussion is often observed in mathematics classrooms. Students tend to work independently in mathematical tasks and
activities, without allowing to communicate and interact with their peers [5]. This can be caused by limited time and adequate conditions in the process of learning mathematics even though the socialization aspect of the mathematical communication is fundamental aspects for critical thinking, problem-solving and developing as a mathematician. Therefore, the teacher as an instructor in mathematics learning must be able to choose the appropriate method to overcome these problems. Blended learning as an approach that mixes face-to-face and online learning activities which is considered by researchers as a quite capable approach to overcome these problems.

Blended learning has taken several models, such as combining web-based technology models, pedagogical approaches, teaching technology and the actual work [6]. Blended learning is an Internet-based and face-to-face learning environment [7][8] that is a traditional environment in complementary models that uses all possible ways for both of them in the education process [9]. That is to say, traditional and computer-based learning methods run together [10]. In addition, according to Khaled, N R A., Blended E-learning is one of the modern education approaches that rely on the use of information technology in designing new educational contexts that enhance active learning strategies and are strategy-centered [11]. Thus, we can conclude that there is general agreement that the main component of blended learning is face-to-face teaching and online learning. The application of mixed learning can: (1) Expand the space and opportunities available for learning; (2) Supporting course management activities (e.g. Communication, assessment of submission, marking, and feedback); (3) Support the provision of information and resources for students; (4) Involve and motivate students through interactivity and collaboration [12].

Nevertheless the results of a review of the literature on blended learning, Oliver and Trigwell have broadened the notion of what is mixed in identifying seven different mixtures [13]. Which were mixing: (1) E-learning with traditional learning; (2) Online learning with face-to-face; (3) Different media; (4) Different contexts, for example, work and study; (5) Different theories of learning; (6) Learning objectives, for example, those concerning skills as opposed to knowledge; (7) Pedagogic approaches, for example, distance and campus-based learning. As with Oliver and Trigwell, Driscoll and Carliner [14] describe four patterns, each of which they call the form of Blended Learning: (1) a mixture of Web-based technologies; (2) a mixture of various pedagogical approaches (e.g. Constructivism, behaviorism, cognitivism); (3) a combination of all forms of technology teaching with face-to-instructor-led conditions; or (4) a combination of instructional technology and actual work tasks to form a mixture of effective and working learning. Blended E-learning is so flexible that it allows students to receive the same message from various sources in different forms in the long run. For example, traditional lessons can be provided and the same material can be presented differently in online [11]. Blended E-learning contributes to mixing learning classrooms with virtual learning to achieve cost balancing in preparing learning programs that help reduce the costs of these programs [15]. Despite the various possibilities of mixing methods in learning, some researchers recommend that the balance in designing educational materials by 50% represent face-to-face activities in the classroom context and 50% including virtual activities on the Internet [16] when designing Blended E-learning environments.

Based on description above, this literature review seeks to examine the benefits of blended learning based on the results of research that has been carried out previously. So based on this review we would like to analyze the correlation between blended learning and mathematics learning. So that we can get an idea of whether blended learning can really be implemented in mathematics learning. The results of this study can be a reference for education practitioners in order to consider the use of blended learning in learning. So that in the future it can produce diverse mathematical competencies for students.

2. Method
Kinds of the procedures and technical use in this literature review method.
2.1 Search procedure
Searching for research articles, the literature analysis was limited to several types of research. The main research analyzed was empirical research to find out more about the effectiveness of blended learning. A literature review was chosen as a relevant study but was not included in the analysis. The formulation of the problem that had been compiled was then searched with several methods that had been chosen. The search procedure was done by searching for as many previous studies as possible. The research sought was about the blended learning model and the effectiveness of blended learning in learning process. In addition, the study of mathematics and e-learning in mathematics learning was also sought through searches in several journals and proceedings.

Looking for several literature studies, the search procedure used was to search databases from Google Scholar, Springer, Z-Library and track citations from a study for follow-up lessons. Some reference search keywords used include blended learning, blended learning in mathematics learning, the influence of the application of blended learning, components, characteristics, advantages and benefits of blended learning, etc. Some journals from search results were also a reference in this literature review. Part of the journal related to blended learning was a reference, including *Eurasia Journal of research in math education*, *Journal of research in math education*, etc.

2.2 Selection criteria
The results of searches in several journals and articles with relevant keywords specified in the search procedure article, some articles about blended learning were obtained. Then, from the articles selected in accordance with the provisions, namely the effectiveness of blended learning or the successful implementation of blended learning based on previous research conducted by previous researchers. The results of the application of blended learning are not limited only on mathematics learning, because there is still little application of blended learning in mathematics learning especially in junior and senior high school.

Furthermore, there are several criteria in selecting articles that have been searched according to the established procedure. The first criterion is focuses on articles with empirical research that includes information about research subjects. This focus is limited to empirical research because what will be studied is the benefit of blended learning in learning process and the research results of the literature review are used to support the results of the analysis. The second criterion is the limitation of the research subject, namely at the level of primary education to higher education. This is done by researcher for that research can be more comprehensive and come from various levels of education. The college level was chosen because the application of blended learning has so far been more widely used in universities. Whereas students in secondary education are chosen because they can provide a strong argument that the application of blended learning is also possible at a lower level.

The third criterion is selected search results articles published in that period 2000-2018. This is intended to make the study reviewed more expected and more legitimate. However, theoretical studies are not limited by the year of publication of an article. Supporting articles are also used even in longer publishing. Based on the four criteria mentioned above, relevant articles obtained 11 empirical articles of research with various kinds of dependent variables. Differences in the dependent variable were chosen to show the benefits obtained from the application of blended learning in learning.

2.3 Formatting author affiliations
The main characteristics of some articles will be defined, this is based on questions in the formulation of the problem. Articles about the effectiveness or success of blended learning are then selected and grouped in table form. The information entered in the table regarding the selected article contains the following content. (1) Author and year of publication; (2) Number of authors; (3) Dependent variables; (4) Research design; (5) Research subject; (6) Research program. This coding strategy is then used as a method for analyzing articles that have been tracked to facilitate categorization.
3. Result
In-depth analysis will be carried out in 11 journal articles that have been previously selected, which are in accordance with the criteria, categories, and procedures that have been set. The information related to the articles can be seen in the Table 1 below.

**Table 1. Overview of studies on blended learning**

| Author                      | Year | Dependent variables      | Research design | Subject                                      | Programs                                           |
|-----------------------------|------|--------------------------|-----------------|----------------------------------------------|---------------------------------------------------|
| Wahyudi., Waluya, B., Hardi, S & Isnarto | 2018 | Creative thinking        | Pre-experiment design (one group pretest-posttest design) | 27 students (one class)                           | Study program of primary school teacher education |
| Ya-wen, L., Chin-Lung, T & Po-Jui, C | 2016 | Blended Learning         | Quasi-experiment | Junior high school student                   | Mathematics                                       |
| Anwar, M., Indiani, M & Syamsuri | 2016 | Content Knowledge        | Quasi experiment | 52 students (30 experiment, 25 control)       | Algebra matric                                    |
| Mulqueeney, Victor, K., Ryaan, S & Jaclyn O | 2015 | Student engagement       | Pilot study     | 3 group students at middle school             | Mathematics                                       |
| Tee, W J., Sharon, L P V., Sarojini, D N & Wong, S Y | 2015 | Learning management, social learning and video | Quantitative approach (Survey) | 35 university students                        | RMIIT degree programs                             |
| Marc, T K                  | 2014 | Student outcomes         | Quasi experiment (non-equivalent control group) | 38 students (blended learning) and 28 students (traditional approach) | Public health course                              |
| Hamidreza, K., Zaleha, I and Yudariah, M Y | 2012 | Communication skill and teamwork | Survey          | 62 first year students                        | Mathematics department                            |
| Sulihin, B S               | 2012 | Motivation and learning outcome | Quasi experiment | 62 students                                  | Vocational high School                            |
| M. Victoria, L-P., M. Carmen, P-L & Lazaro, R-A | 2011 | Perceptions and outcomes | Quantitative (Final Mark) | 985 valid samples                             | Economy and business                              |
| Aynur, G & Funda, D        | 2012 | Student experience       | Survey          | 67 students                                  | Departments of mathematics and primary school education |
| Vanessa, W., Andreas, H., Klaus S & Cord, S | 2009 | Blended learning and problem based learning | a mixed-method study. | 185 third-year students and 14 tutors took part in the study | Aachen faculty Model Curriculum Medicine            |

Based on the results of the selection of journals that supporting this research. In-depth discussions related to the results of the research from the article will be conducted, so that it will be seen related to mathematics learning. First, research conducted by Wahyudi, Waluya, Hardi and Isnarto, obtained
results that blended learning effectively improves students’ creative thinking abilities in solving problems[17]. The reasons why this can occur because learning gives students the opportunity to think systematically by starting and criticizing interesting contextual problems and ending with meaningful reflections with adequate learning resources, both when face to face and online. This research implies that it is true that student creativity can be improved by giving problems to students to find solutions, including in mathematics learning. Student’s creative ability is one problem that requires a solution to be solved.

Second, the research of Ya-wen, Chin-Lung and Po-Jui, showed that blended learning not only gave positive results to student learning outcomes but also had an impact on attitudes towards mathematics. In addition, specifically, the results show that male and high-ability students are more motivated in learning with the blended learning model [18]. This provides reinforcement for the author's initial argument that blended learning can be carried out at a lower level of education, as well as in mathematics learning. The application of blended learning can make efforts to improve mathematics learning outcomes and eliminate negative perceptions of mathematics. Third, research conducted by Anwar, M., Indiani, M &Syamsuri; it is about the strategy to improve content knowledge. Overview of the results from the data showed that the learning outcomes of the blended learning class were better than ordinary classes [19]. In addition, students seem more active in doing assignments than ordinary classes.

Fourth, Mulqueeny, Victor, Ryaan and Jaclyn O's research shows that when using the reasoning mind, blended learning program students show more than 65% of the concentration involved and more than 85% of the time working on the task. This high level of involvement continues for one hour of math lessons [20]. Continuous involvement creates greater opportunities for student learning outcomes. Research on these lower grade of educations shows that there are great opportunities for learning mathematics with blended learning by mathematics teachers in junior high schools. Hopefully it can improve student learning achievement.

Fifth, research conducted by Tee, Sharon, Sarojini and Wong shows that blended learning can increase students’ interest in learning [21]. The increased interest is one positive factor that will result in increased understanding. A high interest in learning will increase the intensity of learning, thus leading to increased understanding. Understanding is one of the cognitive components of mathematics learning goals [22], therefore it is seen that there is a positive correlation in the use of blended learning in mathematics learning.

Sixth, based on the results of a study conducted by Marc that for students in health science courses can be concluded that the blended learning approach can be an effective way to optimize student learning and improve student performance [23]. This shows that it is possible to apply blended learning in the hope of obtaining results in accordance with this study. This is because in previous studies related to mathematics learning, blended learning also gave positive results.

Seventh, research examining communication skills and teamwork, conducted by Hamidreza, Zaleha and Yudariah. The results obtained that blended learning in multivariable calculus programs has a positive impact on students’ communication skills and teamwork [24]. Paul's research also shows that most students (95%) report that they have positive results with blended learning approaches. They prefer active learning methods or peer learning rather than traditional lecture-based instruction, and technology-mediated instruction is very effective in helping them build knowledge [25]. Both of these studies show that through active interaction of students in learning, for example through peer interaction, students' communication and cooperation abilities increase. Then refer to this study, blended learning can be used as a tools to improve the ability of student communication and teamwork on mathematics learning. Communication skill is one of the components of ability that students must have in learning mathematics because one of the objectives of mathematics learning is to grow mathematical communication skills. And this is also in line with one of the demands of 21st-century capabilities, namely communication.

Eighth, the research conducted by Sulihin, found that the motivation and learning outcomes of students had differences between the control class and the experimental class. Further data are obtained as follows. 1) There are different kinds of learning motivation between students taught blended learning compared to students taught conventional learning with values 0.012 with an average
of 4.74 and there are differences in learning outcomes with sig values 0.000 with an average of 13.39. 2) There is an increase in student learning motivation due to the application of blended learning with sig 0.000 average increase of 13.55 and there is an increase in student learning outcomes with sig values 0.000 average increase of 38.23 [26]. The difference in motivation and improvement in student learning outcomes can be a reference or can be an illustration that there are teachers who have applied the blended learning method in mathematics learning and it works. So there is no reason for mathematics teachers to lack teaching method to apply, to overcome the low motivation and learning outcomes of mathematics students.

To promote students’ motivation, various strategies must be used to encourage them to be actively involved in the learning process [27]. Learning motivation can be classified into two types: intrinsic and extrinsic. Intrinsic motivation refers to the performance of an activity because of satisfaction attached to it from external reasons such as rewards, while extrinsic motivation can be defined as carrying out activities to achieve results [28]. The two types of motivation greatly affect students’ learning outcomes. Donnelly revealed that increasing the level of interaction in learning has become a major factor for increasing students’ motivation and for creating positive attitudes, which consequently improves their performance [29]. In addition to increasing motivation, blended learning that is designed must also aim to overcome students’ learning difficulties [30].

Ninth, according to what was done by Victoria, Carmen and Lazaro, utility level, motivation, and high satisfaction were felt from blended learning, which could lead students to have a positive attitude towards learning [31]. In addition, it was shown that online activities including those useful for students, who can have a beneficial influence on the work they do independently. A positive attitude towards learning helps to form good interest and motivation in learning so it is strongly recommended that blended learning is applied in learning process. In addition, blended learning trains students to do their jobs independently.

Furthermore, the research conducted by Aynurand Funda shows that applying for courses especially with electronic activities has a positive effect on students from a learning and evaluation perspective [32]. Students state that a mixed learning environment supports their active participation in course activities and shows that following the course content, homework and online projects is interesting and useful. Because of that, blended learning is one of the supporting facilities to increase students' active participation in learning. Hopefully students will have their own initiative in seeking new knowledge and information related to learning. This is supported by the results of research conducted by Paul [25]. The results of the study show that the blended learning approach leads to more conceptual change, acquisition of more skills, and higher performance. He also added that this discovery could be a reference for the application of blended learning in subsequent learning.

The latest is research by Vanessa, Andreas, Klausand Cord showing that motivation, subjective learning gains, and satisfaction achieved increase significantly with blended problem-based learning compared to learning problem-based learning in a rational manner [33]. In addition, he adds that according to log-file analysis, web-based learning models are often used and can enhance collaboration during self-learning. Based on the results of these studies, it can be analyzed that learning on the basis of giving problems using blended learning is more effective. Because learning mathematics that often uses problems to find or construct a concept in students can combine problem-based learning and blended learning in order to increase the effectiveness in achieving its implementation goals. Based on the results of the analysis that has been done, it can be seen that it is possible to apply blended learning in mathematics learning.

The analysis of 11 articles above shows the positive impact of applying blended learning in various study programs including mathematics. The analysis is in accordance with the results of research conducted by Wee L. Ng, who stated that there is encouraging positive impact of the blended learning on students’ learning of mathematics [34]. The positive impact of blended learning can result in reducing dropout rates and increasing test scores. In addition, students’ perceptions of blended learning are interrelated, with their final grades dependent on mixed learning activities, as well as on students’ age, background, and attendance in the classroom [31]. All these aspects will affect students' attitudes toward learning. The use of technology at lower education can be through simple and easy technology that is and can be understood by students. But at a higher level of education an increase in learning
outcomes can be obtained from the use of new information and communication technology (ICT); this offers a new way of producing, distributing and receiving university education [35]. Learning with the blended learning model also encourages students to be more active in working on assignments than the ordinary class [19]. At a higher level, the difficulties experienced in mathematics learning are certainly different from other lower levels. According to Christina, there are two requirements to counteract the difficulties of mathematics in higher education: the need for personalization (related to the needs of each individual) and the need for collaboration (according to the theory of social construction of competence) [36].

The mathematics that is lot of abstract concepts will be greatly helped by the use of technology in its integration. Moreover, e-learning offers opportunities to use and coordinate multiple representations (graphical, visual, symbolic, verbal, etc.) and to plan activities that are compatible with a pragmatic approach [37]. For students from aspects of the blended learning environment, it provides a great opportunity for students to be free in learning. The online component of blended learning increases students’ agency (allows them to control both instructional and sequence steps), reduce typical disturbances in classrooms or lecture halls, increase assignment time, and improve students’ performance [38]. Blended learning implementation that turns out to be not only beneficial for students, but blended learning is also beneficial for teachers or staff. For example in the case of weekly online practice quizzes to support lecture material and textbooks using automatic tagging functionality that generates direct and automatic feedback to each student about understanding their concepts and practicality avoiding a continuing workload for a gift in staff. In addition, the use of blended learning by teachers is an attempt to expand and add to classroom learning with online exploration and discussion. [39].

The results of the analysis that have been carried out provide a very clear explanation, how the positive impacts that have been obtained from the implementation of blended learning in various types of study programs including mathematics. Therefore, the application of blended learning in mathematics learning for teachers is no longer an impossible thing to do while considering the related aspects of learning fluency, in order to overcome difficulties in understanding concepts, time constraints and disruption of the learning environment that is often experienced by students. In addition, the results of the above studies are also in line with the mathematical components that need to be taught to students, namely critical thinking, creative thinking, conceptual understanding, problem-solving skills and mathematical communication. Thus, it can be stated that blended learning is in accordance with mathematical abilities.

4. Conclusion

Based on a study of 11 articles above, it is concluded that in several programs and levels of education, blended learning has a positive impact. The successful application of blended learning does not only have an impact on students’ achievement but also has an impact on students’ attitudes towards learning. This success is also demonstrated in the application of blended learning to mathematics learning. In addition the results show that blended learning can be used at various levels of education. Therefore, the application of blended learning in mathematics learning needs to be considered.

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