Blended learning: a strategy of current mathematics learning

R M M Sari and N Priatna
Universitas Pendidikan Indonesia, Indonesia

*Corresponding author’s email: mustikasari@upi.edu

Abstract. This article aims to provide an overview of a mathematical learning strategy that can be used in facing the industrial revolution 4.0 in the education world of Indonesia. The background of this article is to explain one of today’s learning strategies, Blended Learning. This article uses analytical and literature review methods. That is, in this case, the increased information and communications technology usage in the learning process in Indonesia is analyzed following the existing circumstances based on relevant books, articles, journals, and other sources. This article examines the characteristics of the blended learning strategy, the procedures for implementing blended learning, and the philosophical foundation of blended learning in mathematics learning. The results from reviewing the articles obtained show that the blended-learning strategy is suitable to use in mathematics learning since students, by use blended-learning strategy, may evaluate their skills themselves as well as determine their learning speed.

1. Introduction
Indonesia is currently facing the Industrial Revolution 4.0, known as the cyber-physical, which is the era of big data, computing, internet, and network. In this industrial revolution era it requires educator professionalism, a dynamic curriculum, reliable facilities and infrastructure, and the role of technology in learning. To face the industrial revolution 4.0, we need to prepare 1) human resource improvement, 2) the role of the government in changing learning strategies/methods, 3) starting education 4.0, as well as 4) the use of ICT in learning. The involvement of ICT in learning activities is now common, both for educators and for students. The development of the increasingly advanced science and technology encourages the world of education to participate in expanding the learning experience [1].

Today’s learning activities are face to face activities. This method is considered effective because it is more flexible in communicating between students and educators or students with students in dealing with problems in learning. However, along with the rapid advancement of knowledge and technology, the acquisition of information must be conducted as actual as possible ineffective time. The face-to-face learning methods are considered unable to cope with the increasingly rapid development of science and technology due to limited space and time. To overcome this, the e-learning method occurs. E-learning is a learning approach that utilizes information and communication technology as a learning facility that enables communication, interaction, and even multimedia teaching materials. Report the results of their research, that learners who learn in e-learning environments feel isolated, frustrated, and confused when faced with two main problems, namely technical and communication constraints. The lack of direct communication processes between students and educators has an impact on the social crisis of the learners involved in it [2]. From the occurring problems, it turns out that learning by the use of ICT does
not necessarily provide convenience in learning and that the lack of communication interactions has an impact on the social crisis of learners involved in the activities. Therefore, it is necessary to develop a strategy for integrating ICT into the design of learning activities that can overcome the problems.

One suitable learning strategy for today’s learning is “Blended Learning,” a learning system that combines e-learning with face-to-face learning that it will accommodate the needs of students to increase their knowledge [3]. Each student has a different style and speed of learning. In face to face learning activities, some students are fast in understanding the material, but some require more time than others. With the blended learning strategy, students who require more time to understand materials, especially in mathematics learning, may relearn by accessing the materials online and evaluate the materials themselves. With the help of ICT, it is possible to present learning in the form of text, images (still or motion), and sounds. These forms that often cannot be carried out in face-to-face learning will make it easier for students to comprehend the materials. For instance, in two-dimensional figure or geometry materials, it is better to carry out technology-based learning.

The effort to improve the quality of education in Indonesia has always been an important issue in the implementation of the National Education System. The important thing to achieve educational goals is by implementing appropriate learning strategies. Learning that combines online-based and face to face learning (blended learning) becomes an intensively discussed issue. Therefore, this paper will examine: 1) blended learning characteristics, 2) procedure for implementing blended learning in mathematics learning, and 3) the philosophical foundation of blended learning in mathematics learning.

2. Methods
This article uses analytical and literature review methods, in the case of the increased use of learning by using ICT in Indonesia. This article is an analysis of existing conditions based on books, articles, and journals published in the last five years as well as other relevant sources to the currently existing case. Therefore, readers will be more aware, and it will be easier for them to understand various things related to the blended-learning strategy in mathematics learning.

3. Results and discussion
3.1. Characteristics of blended learning in mathematics learning
Considered from the epistemology, the term Blended Learning consists of two words, Blended and Learning. The word Blended means “a mixture to improve quality” (Collins Dictionary) or the formula of a combination or integration (Oxford English Dictionary). At the same time, the word learning has a general meaning about learning. Thus, blended learning means learning patterns that contain mixing elements or merging between one pattern with another. Below are definitions of blended learning based on several sources: 1) Blended learning is learning that combines the advantages of teaching in class and e-learning. In this learning, the teacher will give instructions to students who find learning difficulties when in class, while other students can work independently on material that requires reasoning. Students can achieve learning goals if they analyze, speculate, and explore problems independently to get choices or alternative answers to a problem [3]. 2) Blended learning is a combination of direct learning and online learning. Learners need to find an active learning style that suits them [4]. 3) Blended learning is a method that combines face-to-face learning in a classroom with online learning. This is in line with the opinion of Fitzpatrick and Maaaroop, which states that blended learning is a combination of face-to-face learning in the classroom with a virtual environment [1]. 4) Blended learning is the integration of ICT into the learning design to enhance the teaching and learning experience of students and teachers, which makes it possible to use various ways or methods that they might not do in a learning environment that is both face-to-face interaction and distance learning [5].

Besides blended learning, other terms are often used, including blended e-learning and hybrid learning [6]. The terms have the same meaning that is integration, mixing, or a combination of learning. To more easily understand the difference in these terms, “Blended learning has several alternative names, namely mixed learning, hybrid learning, blended e-learning, and melted learning (Finnish).”
Besides, “A better term for ‘Blended Learning’ is ‘blended e-learning’”. In its development, the more popular term is blended e-learning compared to blended learning. The two terms are the latest educational issues in the development of globalization and blended e-learning technology [7]. “The issue of Blended e-learning is difficult to define because it is something new”. Although it is quite difficult to define the meaning of Blended e-learning, some experts researched Blended e-learning and mentioned the concept of Blended e-learning. Besides, the study of Sharpen et al. Therefore, Blended learning can be interpreted as a learning process that utilizes a variety of approaches, the ones that can utilize a variety of media and technology. From the definitions above, it can be concluded that blended learning is a learning strategy that combines various learning methods, both ICT and other methods, to overcome limitations in learning found in direct learning (face to face) with distance learning that applies online learning strategies.

Based on the definitions regarding blended learning stated above, it is obtained the objectives of the strategy. The objectives of the blended-learning strategy include 1) to provide opportunities for educators for educators to independently design and develop teaching materials that are useful and following learning objectives. 2) To help educators develop better learning processes, based on learning styles and learning preferences, and 3) To increase scheduling flexibility for educators by combining the best aspects of face-to-face and online instructions.

The application of blended learning does not just happen. Some things to consider are the characteristics of the learning goals that we want to achieve, relevant learning activities, and choose and determine which activities are relevant to conventional and which activities are relevant for online learning. The characteristics of Blended Learning are: 1) learning that combines various learning models and various learning media based on ICT, 2) blended learning combines direct education, independent learning, and independent learning online, 3) blended learning strategies are supported effectively by combining presenting methods, teaching methods, and learning styles, and 4) teachers and parents of students have an equally important role, where teachers act as a facilitator and parents play a supporting role.

3.2. The procedure for implementing blended learning in mathematics learning
In internet-based learning, a system exists a model that combines face-to-face learning and distance learning, namely the web-centric course model. The web-centric course model is the use of the internet that combines distance learning and face-to-face learning. Some learning materials are delivered through the internet and some through face-to-face, both of which have complementary functions [7]. In this model, educators can provide instructions to students to learn subject matter through the web that has been made. Students are also given directions to look for other sources from relevant websites. In a face-to-face session, students and educators discuss more the findings of material that has been learned through the internet. Online activities are used as support only in providing material, communicating among students or with other sources conducted outside formal learning hours. There are several elements of the blended learning strategy in mathematics learning, which include: 1) Live events, a learning process that pays attention to online and face-to-face learning combinations as mathematics learning considers the direct presence of teachers as something that must be done. The live event combines the theory of behaviorism, cognitivism, and constructivism that mathematics learning is understood, 2) Self-Paced Learning, a process that involves learners in independent learning situations through online learning. This activity combines independent learning which allows students to learn anytime and anywhere by using a variety of contents (teaching materials) that are specifically designed for independent mathematics learning, either text-based or multimedia-based, 3) Collaboration, participation is directed at knowledge development and skills through social processes or social interactions with others for material deepening, problem-solving and project-based learning, 4) The assessment made must consider the combination between online and offline assessment forms and measure the knowledge mastered by students as the impact of implementing blended learning, 5) Performance Support Material, a supporting component that can help students to be more effective in completing learning activities [8].
Before implementing Blended Learning, educators must first prepare all the learning needs, particularly the use of technology platforms that will be used in the learning. Several platforms can be used in Blended Learning:

3.2.1. **Learning management system.** Learning Management System is a commonly used software in virtual classrooms that functions like planning, delivery, and processing of learning activities. It is also useful for documentation, activity reports, administration, and learning materials. It all works using the internet (online). Most web-based LMS is built using various development platforms, such as Java/J2EE, Microsoft.NET or PHP. They usually make use of databases such as MySQL, Microsoft SQL Server or Oracle as a ‘back end’. Although most systems are commercially developed and have commercial software licenses, several systems have an ‘open source’ license. The LMS application is divided into 2: 1) Proprietary LMS, such as Saba Software, Apex Learning, Blackboard, IntraLearn, SAP Enterprise Learning, 2) Open-source LMS, such as ATutor, Dokeos, dotLRN, Freestyle Learning, ILIAS, LON-CAPA, Moodle, OpenACS, OpenUSS, Sakai, Spaghetti Learning. The benefits of using LMS are: learning without a time limit, increasing knowledge in the field of technology, and the ease of learning anywhere.

3.2.2. **Learning content management system (LCMS).** Learning Content Management System is a software developed from LMS so that this LCMS has more functions. Additional features available in LCMS are in the form of being able to oversee the process of learning, providing, detailing funds to publish more specific documents. A content management system is a software that is used to add or manipulate (change) the contents of a website. Generally, a CMS consists of two elements: a content management application (CMA) and a content delivery application (CDA).

3.2.3. **Social learning network (SLN).** This software is a further development from the previous software, LSM, and LCSM. SLN is a further development after LMS and LCMS. SLN is used for broader learning than group learning because it uses social networks. Because of the larger social scale, it is possible that it can also cause changes in attitudes and behavior in participants, although not all participants. An example of a popular SLN application is Edmodo. One example of the application of cyberspace is the use of Edmodo. Edmodo is one of the most widely used software in the Virtual Class learning process between a teacher and students. Edmodo is considered more effective in the learning process, so that many schools use this application as the learning media.

3.3. **Learning theories and philosophical foundation of blended learning application in mathematics learning**

3.3.1. **Learning theory**

3.3.1.1. **Vygotsky learning theory.** Mathematics learning with blended learning, the main role of educators as intermediaries in learning, and interactive activities among students and between students and educators are the main elements in learning. Students must be able to learn independently and must actively collaborate with other learners. This is in line with Vygotsky’s theory of learning, which emphasizes the importance of a person’s active role in constructing their knowledge. Vygotsky’s theory is more accurately called the constructivist approach. That is, a person’s cognitive development, in addition to being actively determined by the individual himself, is also determined by an active social environment. Vygotsky’s theories are based on three main ideas, namely: 1) intellectuals develop when individuals face new ideas and find it difficult to relate these ideas to what they already know; 2) interaction with other people enriches intellectual development; 3) the main role of educators is to act as a helper and intermediary for learning for students.
3.3.1.2. **David Ausubel’s learning theory.** Mathematics learning through blended learning can increase meaningfulness in learning. This is in line with Ausubel’s theory, which is famous for meaningful learning theory. In this theory, learning is classified into two dimensions, 1) the ways to deliver and present learning material to students through acceptance or discovery, 2) how students associate information on cognitive structures that already exist. Ausubel learning theory distinguishes meaningful learning and memorizing learning. Learning through blended learning is one form of meaningful learning because the interaction of students with computers and smartphones can increase students’ interest in learning materials, and they can associate it with the knowledge they already have.

3.3.2. **The philosophical foundation of blended learning implementation**

3.3.2.1. **Constructivism.** Constructivism is a philosophical foundation of contextual learning which explains that knowledge is built by individuals gradually, the results of which are extended through a limited context. The foundation of constructivism states that knowledge is not a set of concepts, facts, or rules that are ready to be taken and remembered, but each individual must construct knowledge and give meaning through real experience. The foundation of constructivism directs students to build their own knowledge through active involvement in the learning process, and the center of activity is students, not teachers.

The foundation of constructivism thinking differs from the view of objectivity, which emphasizes learning. In the constructivist view, the strategy of acquiring knowledge takes precedence that educators are given the task to help the learning process be more meaningful and relevant for students, and educators must provide opportunities for students to find and apply their ideas that students can apply their strategies in learning.

According to the theory of constructivism, what becomes the basis that students gain knowledge is due to students’ activeness itself. The concept of learning, according to constructivism theory, is a learning process that conditions students to carry out an active process of building new concepts, and new knowledge based on data. Therefore the learning process must be designed and managed in such a way as to be able to encourage students to organize their own experiences into meaningful knowledge. Thus, in the view of constructivism, the role of students is very important. For students to have the habit of thinking, it takes freedom and attitude to learn.

3.3.2.2. **Cognitivism.** Cognitivism views learning as an internal process involving memory, thinking, reflection, abstraction, motivation, and metacognition. This theory has a philosophical assumption; that is how we learn (a person’s knowledge is obtained based on thinking). This is what is called the philosophy of rationalism. According to this, we learn is due to our ability to interpret events or events that occur in our environment. What cognitivism theory tries to explain in learning is how people think. Therefore, cognitivism is more concerned with the process of learning rather than the results of learning itself because, according to this theory, learning involves complex thinking processes. Thus, according to cognitivism, education is produced from the process of thinking.

3.3.2.3. **Behaviourism.** According to the theory of behaviorism, learning is a change in behavior as a result of the interaction between stimulus and response. Learning is a form of change experienced by students in terms of their ability to behave in new ways as an interaction between stimulus and response. A person is considered to have learned something if he can show a change in his behavior. Behaviourism theory prefers measurement because the measurement is important to see changes in behavior. Another factor considered important is the reinforcement factor, which is anything that can strengthen the emergence of the response.

4. **Conclusion**

Blended learning can be interpreted as a learning process that utilizes various kinds of approaches. The approaches can utilize various kinds of media and technology. Learning elements based on blended
Blended learning combines face-to-face learning and e-learning, which have 6 (six) elements: 1) face-to-face learning, 2) independent learning, 3) application, 4) tutorials, 5) collaborations, and 6) evaluations. Blended learning has two main categories, namely increased forms of face-to-face activities and hybrid learning. Blended learning has various advantages and disadvantages. Some strategies that prospective educators can take to anticipate the demands of learning in the future are to use Blended Learning.

The blended learning strategy is considered suitable for use in mathematics learning because students with the blended learning strategy can self-evaluate their abilities and determine their learning speed based on their abilities. Besides, this activity combines independent learning, which allows students to learn mathematics anytime and anywhere by using a variety of contents (teaching materials) specifically designed for independent learning, both text-based and multimedia-based (video, animation, simulation, image, audio or a combination of them). The mathematics teaching materials are obtained online through the web or mobile devices.

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