The implementation of multi-platform technology

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Abstract. A single-platform technology is currently shifting to a multi-platform technology as the industrial revolution era is also developing. This study aims to identify the implementation of multi-platform technology in the industry-driven educational context. It has been found that multi-platform technology has a more effective and efficient effects either in the educational or the industrial context. It is also implied that a mobile-based multi-platform technology is preferred due to its accessibility and usability.

1. Introduction
Currently, the development of information and communication technology, especially web-based internet applications, is happening quite rapidly [1]. One example of this application is a multi-platform application or also known as cross-platform [2]. The use of multi-platform technology is undeniably an essential and integral part of various sectors of life, including in education [3]. It seems that the presence of multi-platform technology in the world of education is inseparable from the presence of smartphones and tablet computers that help in the learning process as a result of practical considerations, personalization, modernization, and minimizing the cost of procuring learning facilities [4]. Multi-platform applications have changed the patterns of learning and teaching behavior to be more innovative [5], fun [6], dynamic [7], and help students to think critically [8].

Multi-platform application is a multimedia software, which supports several operating systems and several different devices [9]. Multi-platform applications are web-based applications that can be executed on several devices such as smartphones, PCs, and gadgets [9]. Operating systems that support this application include Blackberry OS, Android OS, IOS, and Windows Phone OS [2,10]. This application was developed by integrating several computing technologies such as web, hybrid, and native [1,11,12]. Learning by using multi-platform applications is also known as multi-platform learning or cross-platform learning [9,13,14]. Multi-platform applications can facilitate learning innovations in the digital age, such as mobile learning, blended learning, self-study / independent learning/self-determined learning, and distance learning [15,16].

This paper aims to conduct a literature review by analyzing a number of journal articles that discuss multi-platform technology as a medium of learning within the scope of education. Through this paper, it is explained the use of multi-platform technology in the world of education.

2. Methods
The literature review in this paper is carried out to describe multi-platform applications as learning media in the world of education. The literature review method is a method for interpreting a number of selected documents on a particular topic through summarizing, analyzing, and evaluating papers [17].
This method is used to understand the issue and identify research links on a topic and develop a theory [18]. Literature review on this paper is carried out with several stages, such as identification of research questions; identification of the journal with relevant studies; journal article selection; collect, summarize and report findings from journal articles related to multi-platform applications in the field of education.

Literature review, which is used to complete the presentation in this paper, is carried out on a number of journal articles that are relevant to the topic of technology or multi-platform applications in the world of education. The year of publication of selected journals is limited from 2015 to 2019. The collection of journal articles begins with a search of several databases search engines such as Google Scholar, Scient Direct / Elsevier, Taylor and Francis, IEEE Explore Digital Library, Springer, Emerald, Crossref metadata search, and ERIC. Keywords used to search for journal articles include "multi-platform", "cross-platform", "multi-platform technology", "cross-platform technology", "multi-platform learning", "multi-platform learning", "multi-platform technology in education", "cross-platform technology in education", "technology uses in education", "technology integration in education", "social media learning", "multi-platform technology in education", and "multi-platform application development", and "software architecture".

| Table 1. Inclusion and exclusion criteria for selecting journal articles |
|-----------------------------|-----------------------------|-----------------------------|
| **Category** | **Inclusion** | **Exclusion** |
| Language | English and Indonesian journals | Written in other languages |
| Year | Starting in 2015 | Before 2015 |
| Type | Empirical research published through national journals and international journals, thesis, short articles, and non-empirical research reports |  |
| Content | Relating to multi-platform or cross-platform learning applications or technology integration in education | All disciplines that are not related to multi-platform or cross-platform technology. |

Journal articles that meet the criteria, then the next stage is content analysis. Simple content analysis is done to interpret what is actually discussed in the text of a journal article [19]. The results of the analysis of the article, then in this paper set forth in tabular form.

3. Results and discussion

Multi-platform applications that are currently used as learning media in the field of education, developed in various forms. Examples of these can be seen in the following table.

| Table 2. Examples of multi-platform applications in education |
|-----------------------------|-----------------------------|-----------------------------|
| **Form** | **Journal Article** | **Type** | **Features** |
| e-book / e-textbook | [9,20-23] | E-botik, Mobile libraries, Digital libraries. | Audio, video, in-text linking, full-text searching, note sharing, quizzes, augmented reality, etc. |
| Mobile Instant Messaging (MIM) and Media Sosial | [15,21,24-27] | Facebook®, Twitter®, Line®, WhatsApp® and Youtube®. | Messaging, groups, videos, video calls, graphics, voice notes, file/document sharing, the status of users, maps, and so on. |
| Learning Management System (LMS) | [2,28-34] | E-Learning Center, E-learning FUOLC, CPMLS, Microlecture, Blackboard, Edmodo, Sakai, Moodle, KEWL. | Video lectures, test quizzes, chat rooms, speech recognition, discussion forums, assignments, learning materials, send/return assignment mechanism, peers discussion platform, immediate feedback on the online quizzes, timeless access to learning materials, communication with peers and lecturers, collaborative group work, calendar as a reminder, news announcements, and performance dashboards and various other features. |
The use of e-books and e-textbooks is based on some previous studies, mostly middle and high school students. Besides, electronic books are also used for specific academic purposes. Another exciting finding turned out that students prefer to use print books rather than e-books or e-textbooks for reading activities that require more time [22].

Still, in a similar study, it turns out that multi-platform applications that are now the most popular used in education as a learning media are Mobile Instant Messaging (MIM) and Social Media. This type of multi-platform application is generally more desirable. In addition to practicality considerations and can add friendship, also in terms of a more flexible appearance. This type of application is entirely up to date because it always looks up to date and can even be modified according to the user's wishes. MIM and Social Media are also quite supportive of the learning process that allows it to occur naturally, both informal, nonformal, informal and workplace education [7,15].

Other research also suggests that the Learning Management System (LMS) is starting to become one of the multi-platform applications that have been developed and implemented as a learning medium in education. Through LMS, various learning media can be integrated into one software ecosystem, so that access to learning resources becomes more accessible and more uncomplicated [29]. Furthermore, similar research reports were obtained that it turns out that multi-platform applications that are currently being developed with the target of students at the level of primary and secondary education are types of educational games and video games. It seems that this multi-platform application is indeed, entirely by the characteristics of elementary and secondary students who are still imaginative and cheerful [10,14].

The use of multi-platform applications as learning media in the field of education, on the one hand, does have many advantages, but on the other hand, also has weaknesses [4,15,20,23,41]. Some of these advantages: can save the cost of organizing learning facilities, which initially required a lot of tools to deliver learning material, has now become more practical because it is enough to only rely on one device with the availability of media variants in it. Another plus is accessibility because learning activities can be carried out anywhere and at any time without limited space and time. Besides, learning media in the form of multi-platform applications are also easy to use and actively support learning activities that are more communicative and interactive, because they facilitate interaction activities among users. Previous research also mentioned multi-platform applications possible to enable distance learning activities, support student-centered learning, train high order thinking skills, train problem-solving skills, save time, increase student learning motivation and improve lifelong learning skills. Students can determine independently what is needed and wanted by them in learning activities. This way is undoubtedly following the learning model that is currently developing, namely heutagogy learning [4,14,42,43].

As for the weaknesses of the use of multi-platform applications, the most dominant is internet access because multi-platform applications are internet-based applications. If internet access is available, then the facilitation of learning activities can be done well. Conversely, if there is no internet access, it will become an obstacle in the learning process, this often happens generally in rural areas. Another weakness is that it can cause fatigue in the eyes because the most dominant sense is forced to work the eye, which takes a long time to look at the screen of the device. Then, in multi-platform applications also often have difficulties in controlling or monitoring messages conveyed by users, so it is not

Table 2. Cont.

| Educational games and video games | Educational software | Characteristics |
|----------------------------------|----------------------|-----------------|
| [10,14] Educational Ornament Tradisional Bali, UMIGO. | [11,13,16,21,35-40] Online laboratory, virtual reality, augmented reality, user interface design patterns, programming, visual geo-localization, mobile learning, and various other types. | 2D drawings, learning material, paint, puzzle games, multi-touch, sound, music videos, live-action crafts segments, image file storage, etc. |
|                                  |                      | 3D graphics, communication, video, sound, augmented, 3D virtual environment, technical features, multi-user collaboration, graphics, and others. |
uncommon to raise doubts in the validity of the information received [15,23]. It was also pointed out that the use of a multi-platform application as a learning medium, could be one factor in the decline in morals or ethics of users in interacting or sharing information. Besides, sometimes the contents of multi-platform applications become biased due to the lack of balance between educational content and entertainment content [41].

4. Conclusion
This literature review discusses some previous research that raises the topic of multi-platform applications or also known as cross-platform, in the field of education. Several databases have been selected to obtain journal articles that are relevant to the range of published years from 2015 to 2019. Content analysis is carried out on several journals that have been sorted. The results show that multi-platform applications are currently becoming a trend in the field of education can be quite useful tools to facilitate online learning and support the concept of heutagogy learning for the realization of students who have lifelong learning skills. As learning media, multi-platform currently developed in various types. The type that most become a topic of previous studies is the Mobile Instant Messaging and Social Media applications. Multi-platform applications as learning media, on the one hand, do have a variety of benefits, but on the other hand, it also has some weaknesses. But an essential thing in this regard is that learning by using multi-platform applications is in harmony with the characteristics of millennials generation learning innovation patterns in the digital age.

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