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INFORMATION & COMMUNICATIONS TECHNOLOGY IN EDUCATION | RESEARCH ARTICLE

Empowering mathematics teachers' ICT readiness with android applications for Bring Your Own Devices (BYOD) practice in education

Maman Fathurrohman^{1*}, Hepsi Nindiasari¹, Nurul Anriani¹ and Aan Subhan Pamungkas¹

Abstract: This research aims to provide android applications to empower mathematics teachers' information and communication technology readiness. The purpose is to facilitate them, due to availability and widely distribution of Android devices, to support them in Bring Your Own Devices (BYOD) practice in mathematics education. The method used is survey to mathematics teachers followed by design and development of the applications. The survey results show six indicators of the Information and Communication Technology (ICT) readiness: (1) understanding ICT in education, (2) curriculum and assessment, (3) pedagogy, (4) ICT, (5) organization and administration, and (6) teacher professional learning, already achieved in the surveyed area. The applications developed, Guidelinks to facilitate the use of internet-accessible resources and LDSoft to document and share teachers' learning designs, are the result of mathematics teachers' need and researchers' capabilities analysis. Both purposed for use by mathematics teachers in internet-connected environment, either at school or home, that benefit for use in Covid-19 Pandemic situation. Teachers can be empowered to optimize the use of their own devices for use in teaching and learning practices.

Subjects: Information Science; Information Technology

Keywords: technology-based kit; mathematics teachers; Bring Your Own Devices (BYOD); Android

ABOUT THE AUTHOR

Maman Fathurrohman and co-authors are part of Mathematics/Statistics Educational Design and Development Research Group at Universitas Sultan Ageng Tirtayasa. This article reports part of the research project design and development financially supported by the Indonesian government.

PUBLIC INTEREST STATEMENT

This research aims to provide android applications to empower teachers' readiness in using ICT devices. The purpose is to facilitate them, due to availability and widely distribution of Android devices, to support them in Bring Your Own Devices (BYOD) practice in mathematics education. The applications developed, 1. Guidelinks to facilitate the use of internet-accessible resources and 2. LDSoft to document and share teachers' learning designs, are the result of teachers' need and researchers' capabilities analysis. The applications now available at Google Playstore. Both applications purposed for use by teachers in internet-connected environment, either at school or home. Teachers can be empowered to optimize the use of their own devices for use in teaching and learning practices.

1. Introduction

This research is started with ubiquitous phenomena that mobile Information and Communication Technology (ICT) devices (such as Android tablets, Windows computer laptops) and internet access cost by the time are cheaper and achievable by teachers. Many of them, including their students, now have and able to bring these devices to schools. This condition may be useful to cover the condition of ICT infrastructure and facilities, especially in the area that are usually low. The problem is, without direction, they will use the devices for fun experiences (for example, accessing Facebook for social purpose and Youtube for music videos) and not for benefit in education.

The rise of mobile technology gives impact on various aspects of human life, including the education. It is necessary to improve the quality of education. Devi et al. (2012) explain that in primary, high school or secondary level (High and senior secondary levels) and the college or higher level (including college, university levels), this technology can be utilized for better teaching learning process and improving quality of education. Fathurrohman (2014) reveals that new technique in relate to technology can be help in mathematics teaching and learning.

Information and Communication Technology (ICT) has a considerable role, especially for teachers. The teacher's role after the entry of ICT is no longer merely as the source of knowledge, but even makes it as a facilitator of student learning partner. Therefore, teachers are required to have the readiness to use ICT. There are six indicators of the Information and Communication Technology (ICT) readiness, namely (1) understanding ICT in education, (2) curriculum and assessment, (3) pedagogy, (4) ICT, (5) organization and administration, and (6) teacher professional learning (UNESCO, 2011). In addition, the digital competence for teachers is importance as advocated by Guillén-Gámez et al. (2019), while Seifu and Wang (2020) investigate factors that determine the integration of ICT in teaching and learning process. Teachers' perceptions on technology, especially ICT is important in the process. Choy et al. (2015) provided the case study regarding this.

The use of ICT in the mathematics classroom has long been a topic for consideration by mathematics teachers. Mathematics is closely related to technology, in contents as well as practices. Some examples of tools used in mathematics teaching and learning include mobile devices, graphic calculators, specialised software, programmable toys or robots, spreadsheets, and databases. Agyei and Voogt (2010) research has shown that a range of mobile devices exists, which allow pupils to collect data and manipulate it using spreadsheets and databases for work in numeracy. In a world of rapid technological change, where learners are becoming increasingly accustomed to new ways of finding information and communicating with each other, teachers are having to face up to the challenges and opportunities involved in learning how to successfully use technology in their teaching practices. This includes supporting students in their use of technology for learning purposes (Holmberg, 2014).

According to Albirini (2006), teachers' attitudes toward computer technologies are also related to teachers' competence in using the technology. In addition, it has relationship with students' academic achievement (Park & Weng, 2020). It has significant impact to new experiences then reflect and implement the changes. ICT should be effectively used in classrooms or homes, for example, during COVID-19 Pandemic year 2019 to present.

1.1. Problem statements and the research questions

Availability and widely distribution of ICT devices and internet access have transformed people lives and social impact. As education is part of social processes, the education activities are also influenced by this situation. There is, theoretically, internet-connected environment in which teachers can use ICT devices and internet access for use in education either at school or home. Among the widely used and distributed tools are android devices. There is uncommon that schools or universities provide it for education purpose, as the devices is categorically as personal. The internet-connected environment, in which the teachers can use the devices connected to internet without limitation of time and internet data package should support them in Bring Your Own

Devices (BYOD) practices. The area of interest for this research is mathematics teaching and learning, where the subject of interest is mathematics teachers in Banten Province, Indonesia.

One proposed solution to this situation is to provide a kit, arguable as technology-based or -enhanced kit, for use by mathematics teachers to empower them to use their own devices that they use in schools, classes, or home. It is also acknowledged, through personal observation, that android tablets are common device widely used by mathematics teachers in selected area. The kit would be in android application package, optimizing the teachers own use of mobile devices and internet access for use in education in schools, classes, or home, in this case is mathematics education. Internet access is usually available, provided by several service providers through market price competition, to enable availability of internet access with achievable cost and adequate quality. Mathematics teachers' need for the kit and whether the proposed kit can work as expected in their natural environment is still to be discovered.

For that purpose, this research aims to develop a technology-based kit suitable for use by mathematics teachers. General framework used is survey followed by design and development, by considering users (mathematics teachers) need and researchers capability in developing the kit. User need assessed by survey in accessible area of six districts in Banten Province, Indonesia. Similar survey with different respondents conducted by Mailizar and Fan (2020) with different subjects and purposes. Purpose of this survey is to discover mathematics teachers' readiness to that such technology to be implemented. The purpose is to facilitate mathematics teachers, due to reachability and availability of internet supported Android and Windows devices, to support them in Bring Your Own Devices (BYOD) practices in mathematics education.

2. Method

The method is survey followed by design and development. Purpose of implementation is to provide concrete and pragmatic solution for problems in education, especially in how to empower teachers and lecturers to optimize their ICT readiness and ownership of ICT devices for use in teaching and learning. Ross et al. (2008) stated that the design and development research seeks to create knowledge systematically derived from practice [Figure 1](#).

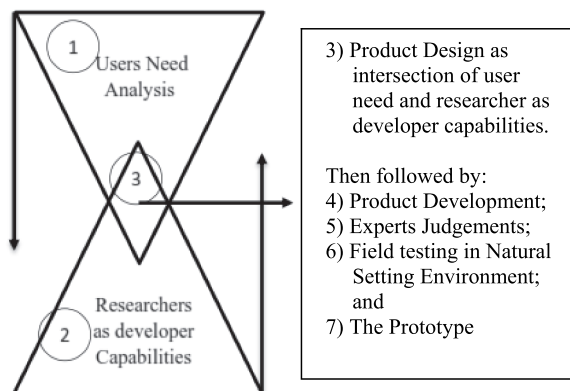
Design and development research tends to be complex methodologically. This is typically because of the complexities of real-life situations and of the design and development process themselves. This research tends to employ either mixed-method or multiple method approach (Ross et al., 2008)

Design and development studies often involve collaboration between researcher and practitioners using a wide range of qualitative and quantitative techniques. Together they work to add to the instructional design knowledge based by studying the nature of the designer and the design processes, often using projects from natural work environment. (Ross et al., 2008)

It is related to statement as Borg and Gall explained that "Educational research and development (R&D) is a process used to develop and validate educational production". Other authors also have proposed their definition, design, steps, and/or approach in relate to this method of research, including Fathurrohman (2014) who proposed the scientific approach for design and development, in which the product developed contribute to the existing body of knowledge, and the product the developed is intersection between user need and researcher capabilities, as illustrated in the following diagram:

The steps of scientific design and development consist of 1) Need Analysis; 2) Researchers Capability Analysis; 3) Design; 4) Development; 5) Experts Judgements; 6) Field testing in Natural Setting Environment; and 7) The Prototype.

Figure 1. Concept of scientific design and development.



The survey conducted before design and development study with purpose to know the ICT readiness of mathematics teachers in six districts of Banten Province, Indonesia. UNESCO (2011) has grouped teacher ICT competencies into six aspects (domains/regions), namely: (1) Understanding ICT in Education, (2) Curriculum and Assessment, (3) Pedagogy, (4) ICT, (5) Organization and Administration, and (6) Teacher Professional Learning. These indicators can be used to know the readiness of mathematics teachers in using ICT for learning. This is to emphasize whether mathematics teachers must be empowered to use their own mobile devices for use in teaching and learning by Technology-based Kit. A total of 800 questionnaires packages were distributed to mathematics teachers with 551 participated by full or partially completed the questionnaires, giving response rate of 68.75%. The survey is important to know teachers' readiness with ICT. Part of survey results used to justify the development of android applications. Researchers hired computer programmers to develop the applications.

Focus of research was investigation of how to design and develop Android-based applications, and the measure of product use ability and the teacher responses on it. The data is obtained from several instruments consist of 1) Documentation, 2) Expert judgments questionnaire for assistance in product development, and 3) Questionnaire to measure the product use ability in natural setting environment and the teachers' responses on.

3. Results and discussion

3.1. Mathematics teachers' ICT readiness

The readiness criteria of mathematics teachers in using ICT for learning as displayed in Table 1 are determined by using normative criteria of percentage justified as following. The survey conducted before design and development study with purpose to know the ICT readiness of mathematics teachers in six districts of Banten Province, Indonesia, based on UNESCO ICT readiness.

The use of mobile devices is related to ICT infrastructures, facilities, and resources in teachers' area. In addition, the use of mobile devices related to teachers' knowledge and experience to ICT. For that reason, main components of the survey include ICT infrastructures, facilities, and resources in teachers working area, including school and home. ICT devices and services in this research consist of mobile devices such as laptop or PC notebook, Android tablet and iPad, smartphone, and internet access.

Table 1. Criteria mathematics teachers in using ICT for learning

Percentage	Criteria
80% < P ≤ 100%	Strongly Ready
60% < P ≤ 80%	Ready
40% < P ≤ 60%	Quite Ready
0% ≤ P ≤ 40%	Not ready

(A) Need analysis

The survey was conducted at the middle school level, high school (junior high school, senior high school, and vocational), or before university level. The research covers public and private schools with the criteria of the schools have accredited spread across several cities and regencies in Banten Province. Respondents of survey is 551, with 176 (32%) of them male, mathematics teachers from various high schools in Banten Province.

The demographics shows that 468 of 551 (84%) participants hold bachelor's degree, while 72 (13%) hold master's degree, with 88% of both of their field degree in education. However, only 79 (14%) of total participants have frequent (more than 5 times per year) ICT in education-related training or courses while working as teachers, while 117 (21%) have no ICT-related training experiences. This situation reflect situation that majority (more than 60%) of respondents have modest number (1 to 5 times per year) of ICT in teaching and learning training and/or courses during their careers as mathematics teachers. In general, this situation is enough that mathematics teachers in this area have at least have several experiences with ICT use in teaching and learning.

1. Mathematics teachers' readiness on aspects of understanding ICT in education

Table 2 indicates that the readiness of the mathematics teacher in understanding ICT in education aspects is get into the criteria "quite ready". The results show that as many as 268 of the 551 respondents with a percentage of 49% replied that they had knowledge of policies on the use of ICT. Teachers know that policy through training and/or books.

2. Mathematics teachers' readiness on aspects of the curriculum and assessment

Table 3 indicates that the readiness of mathematics teachers on aspects of curriculum and assessment are categorized as "quite ready". Moreover, as explained in the following table, it seems as many as 95% of respondents use a PC at home for preparing mathematics for use in school and generally use the computer as much as 3–5 times per month, and there's 68% of respondents use the technology which is laptop or notebook to create learning resources. Then, as many as 30% of respondents use Powerpoint and learning media-based ICT by using laptop and projector for mathematics learning.

Table 4 shows the crosstab between ICT training and the intensity uses of the computer for preparing mathematics teaching and learning, display relation between them. Through this data, the chi-square test show that there is significant correlation between the number of ICT training and the intensity of using computer for preparing mathematics learning. This imply that there is a significant correlation between the number of ICT training and the intensity of using computers at home for preparing mathematics learning. It concluded that the more often teachers followed ICT training, the more often teacher use a computer at home for preparing mathematics learning.

3. Mathematics teachers' readiness on pedagogical aspects

Table 2. Understanding ICT in education aspect			
No	Indicators	Percentage	Criteria
1.	Teachers have knowledge of policies on the use of ICT	48.6%	Quite Ready
2.	Teachers were able to implement this policy in the classroom	41.4%	Quite Ready
Average		45%	Quite Ready

Table 3. The curriculum and assessment aspect

Indicator	Percentage	Criteria
Teachers can use technology to prepare a lesson plan design or mathematics	59.82%	Quite Ready
Average	59.82%	Quite Ready

The results showed that mathematics teachers' readiness on aspects of pedagogy are categorized as "quite ready". This is seen the most teachers have applied mathematics-based computer or internet, including by assigning students to browse or search for content on the internet amounted to 40%, using power point to deliver learning materials amounted to 24% and using mathematical software in the learning amounted to 7%. Based on the interview with several teachers who apply computer or Internet-based learning, they give assignment to students to use computer or internet to search for learning materials on their own. Another use is to provide PowerPoint presentation in classroom or creating technology-based quiz. In terms of using technology as additional learning resources, most teachers in Banten use PowerPoint with percentage of 14%, GeoGebra 10%, and e-book 7%. Several teachers said that by using GeoGebra it makes students' understanding geometry concepts much easier.

4. Mathematics teachers' readiness on aspects of information and communication technology

The results showed that mathematics teachers' readiness on the aspect of technology, information and communication are categorized as "ready". This looks at teachers using notebook and projector for teaching mathematics in the classroom is as much as 1–2 times per month. Based on the interview with several teachers, they always use a notebook and projector in their class. This is because they feel by using a notebook and projector makes them easier to teach. By using a notebook and projector, they are no longer write or draw learning materials on the board. It also helps students understand mathematical concepts, especially related to the field of geometry.

Teachers often use smartphones to access the Internet at school and at home. Software for learning mathematics most widely used by teachers is Microsoft Office, either Microsoft Word for 68% (335 teachers), Microsoft Excel amounted to 68% (334 teachers), as well as Microsoft PowerPoint by 71% (350 teachers), GeoGebra amounted to 43% (78 teachers), and Pesona edu 13% (24 teachers). Microsoft Office is the basic software that is currently to be controlled by the teacher. So, many teachers have used it. This is because the administration of learning, such as lesson plan, analysis, learning materials, attendance, and others must be made by the teacher using Microsoft Office.

The most teachers, 304 from 551 teachers, have android tablet or iPad that used for learning mathematics as much as 1–2 times per month. They use it to find learning materials and have never used android tablet or iPad for learning in the classroom. However, there are many teachers who do not have a tablet, for reasons already have enough with their smartphones and tablets.

As summarized in Table 5 and 6, teachers who have not been trained tend to never use a notebook and a projector for teaching mathematics. Meanwhile, as displayed in Table 7 and 8, teachers who attended training either 1–2 times, 3–5 times, or more than 5 times had the same trend, using notebook and projector for teaching mathematics as much as 1–2 times per month. Chi-square test shows the significant correlation between number of training and the intensity of using notebooks and projectors for teaching mathematics. This imply that there is a significant

Table 4. Tabulation between total ICT training and intensity use of computers

Number of ICT training	The intensity uses of the computer for preparing mathematics teaching and learning											
	Never		1-2 times per month		3-5 times per month		6-10 times per month		More than 10 times per month		Total	
	F	%	f	%	f	%	f	%	f	%	f	%
Never	15	2.85	43	8.17	26	4.94	12	2.28	10	1.90	106	20.15
1-2 times	21	3.99	65	12.36	67	12.74	26	4.94	38	7.22	217	41.25
3-5 times	7	1.33	34	6.46	44	8.37	19	3.61	23	4.37	127	24.14
More than 5 times	3	0.57	21	3.99	20	3.80	8	1.52	24	4.56	76	14.45
Total	46	8.75	163	30.99	157	29.85	65	12.36	95	18.06	526	100

correlation between number of training and the intensity of using notebooks and projectors for teaching mathematics.

5. Mathematics teachers' readiness on the organizational and administrative aspects

The results of the above table shows the readiness of teachers on the organizational and administrative aspects included in the category "ready" with the average percentage of 61%. This is evidenced by the results of each indicator that can be achieved with good teachers. In the first indicator, teachers have used email or social media with an average of 3–5 times per month. On the second indicator, the teacher explains that the infrastructure and facilities in the school enough to support the learning process of mathematics-based computer and the Internet so that it can be a learning experience for the students.

The result of cross tabulation between the number of ICT training and the intensity of teachers communicates via e-mail or social media with students/other teachers by using Chi-square test show that the significant correlation between the number of ICT training and the intensity of teachers communicate via e-mail or social media with students/other teachers. This imply that there is a significant correlation between the number of ICT training and the intensity of teachers communicate via e-mail or social media with students/other teachers.

The table above shows the intensity of most teachers communicate via e-mail or social media with students/other teachers is 1–2 times per month by 185 teachers (34%). While the teachers who have been trained at the most, followed by 222 teachers (41%) of 1–2 times. Apparently from the [Table 8](#), most teachers have had training 1–2 times have been using e-mail or social media to communicate with students/other teachers as displayed in [Table 9](#) with an average use of as much as 1–2 times per month.

6. Mathematics teachers' readiness in the aspect of teachers professional learning

Table 5. Pedagogical aspects		
Indicator	Percentage	Category
Teachers use the computer lab for learning mathematics	25.1 % (139 teachers)	Not ready
Teachers apply mathematics contents with computer or internet to students	65.7 % (363 teachers)	Ready
Teachers use technology as a source of additional learning	56.6 % (313 teachers)	Quite Ready

Table 6. Aspects of ICT		
Indicator	Percentage	Category
Teachers use a notebook and a projector for learning mathematics	41,15%	Quite Ready
Teachers use a smartphone to access the Internet at school and at home	72,95%	Ready
Teachers use of educational software for learning mathematics	84,66%	Very Ready
Teachers use android tablet or iPad for learning mathematics	49,83%	Quite Ready
Average	63,40%	Ready

Table 7. Cross tabulation between number of ICT training and the intensity of using notebook and projector for teaching mathematics

Number of ICT training	Teachers use of notebook and projector to learning mathematics											
	Never		1-2 times per month		3-5 times per month		6-10 times per month		More than 10 times per month		Total	
	f	%	F	%	f	%	f	%	f	%	F	%
Never yet	61	11.36	40	7.45	6	1.12	0	0.00	3	0.56	110	20.48
1-2 times	76	14.15	89	16.57	44	8.19	8	1.49	6	1.12	223	41.53
3-5 times	28	5.21	55	10.24	28	5.21	7	1.30	7	1.30	125	23.28
More than 5 times	20	3.72	27	5.03	14	2.61	6	1.12	12	2.23	79	14.71
Total	185	34.45	211	39.29	92	17.13	21	3.91	28	5.21	537	100

Table 8. Organizational and administrative aspect

Indicator	Category	Percentage
Teachers communicate via email or social media with students/ other teachers	Quite ready	56.10%
Teachers use a resource or learning material math-based computer or internet experience in supporting the learning of mathematics	Ready	76.41%
Teachers provide support to fellow teachers for the creation of community-based ICT in schools	Quite ready	49.73%

The results of the study after the recapitulation shows that mathematics teachers' readiness in the learning aspects of professional teachers are categorized as "quite ready". This looks at network usage indicators for the learning of mathematics, the intensity of math teachers in using the Internet for learning math as much as 1–2 times per month. Based on the interview with one of the teachers who use the Internet for learning say that the teacher never uses Quipper school's quiz online. Learning with the Internet would create a wider knowledge of the students, in addition to the teachers also can innovate and not monotonous using the textbook only.

Currently, the development of more advanced age, by utilizing the Internet as a learning resource to improve the quality of education in Indonesia. In this case of course dependent on the ability and readiness of a teacher in utilizing the Internet as a source of learning in the learning process. However, there are still schools that are not facilitated by the Internet. They said that the inadequate facilities at schools to access the internet the teacher should use a private facility that has, such as modems, smartphones, and so on. In addition, other teachers say that the school is unable to reach the location of the signal and teachers are also still not really need. Based on the analysis of data readiness level math teachers in using the Internet for learning mathematics by 43% to the category of "quite ready".

Furthermore, the intensity of teachers in accessing the blog of the school as a source of information as much as 1–2 times per month because many teachers said that the school blog is not always up to date so that teachers very rarely access it. And the reason the teacher said the school does not have a website or blog address because until now the school has not made it so most no information about the teacher that can be accessed online. In addition, for the possession of personal blogs, a mathematics teacher in Banten say never use blogs to the learning experience. Based on interviews with one of the teachers who use personal blogs in teaching that the use of personal blogs to experience the learning of mathematics, teachers download materials and tasks into a personal blog for further downloaded by the students. As for the reason teachers do not have a website address or personal blog because teachers do not require a website or personal blog for learning activities and some other teachers who answered do not understand how to create a website or blog and not interested in using it. Based on the analysis of data readiness level math teachers in accessing the website or blog address of the school as a source of information and use personal websites or blogs to the learning experience by 44% to the category of "quite ready".

Intensity of the teachers in the use of Internet access show 3–5 times per month. However, there are teachers who do not provide internet access at home. Teachers said the teachers have not installed internet access, and now the Internet can be accessed by smartphone. Based on interviews with teachers who use the Internet in preparing study says that Internet use is very helpful because teachers will be easier to set up, especially learning to look for additional materials and images in support of learning materials. In this case, supported by result of [Table 10](#), the use of Internet technology in the preparation of learning should be done by teachers for teachers to

Table 9. Cross tabulation between number of ICT training and intensity of teachers communicate Via E-mail or social media

Number of ICT training	The intensity of the teachers communicate via e-mail or social media with students/other teachers											
	Never		1-2 times per month		3-5 times per month		6-10 times per month		More than 10 times per month		Total	
	f	%	F	%	f	%	f	%	f	%	F	%
Never yet	29	5.42	42	7.85	21	3.93	11	2.06	8	1.50	111	20.75
1-2 times	36	6.73	77	14.39	52	9.72	23	4.30	34	6.36	222	41.50
3-5 times	9	1.68	39	7.29	30	5.61	13	2.43	33	6.17	124	23.18
More than 5 times	10	1.87	27	5.05	14	2.62	7	1.31	20	3.74	78	14.58
Total	84	15.7	185	34.58	54	10.09	54	10.09	95	17.76	535	100

Table 10. Teachers professional learning aspect

Indicator	Percentage	Category
Teachers use the Internet for learning mathematics	43.80%	Quite Ready
Teachers access the school website or blog address as a source of information and use personal websites or blogs to the learning experience	43.69%	Quite Ready
Teachers use the internet access available at home for preparing mathematics learning	60.27%	Quite Ready
Teachers create or develop resources or learning material math-based computer or internet	53.55%	Quite Ready
Teachers actively participated in activities of community learning	68.24%	Ready

further develop teaching methods to be more varied and not monotonous because on the internet provided a variety of information teachers need to develop learning.

3.2. Survey discussion

Information technology (IT) has opened wide opportunities for educators to integrate technology-supported materials in the teaching-learning process and to improve the achievement of students. The use of computer-aided technology in the classroom will, no doubt, inspire the teachers to approach their tasks with a greater sense of purpose and, more importantly, a sense of play to make the learning process fun for students. Using computer-based technology such as data-logging and simulations is important for modeling subjects such as science and mathematics (Kumar et al., 2008).

The Education Office of Banten Province, Indonesia, as a regulator also have paid more attention to the teachers to be able to master ICT tools. Government regularly conducting training for elementary school teachers and junior high school teachers. The training with the name of the “Training and Development of Teaching Materials Based E-Learning, aims to enable the participants to utilize, develop, utilize, Information and Communication Technology (ICT), especially the use of e-learning as an alternative medium of learning and media information, so that teachers can improve the effectiveness of professional learning as a teacher, this phenomenon illustrates that the government was also concerned about education and understand the importance of ICT in learning at school. In addition, through the facilities of communication and information technology we can transfer ideas and adopt a system of education in developed countries education. This will provide a positive impact on improving the quality of education in Indonesia in the eyes of the international community. The adoption of the idea and the system happen because look at the quality of education in Indonesia is very low. The low quality of education is less quality impact of human resources and the absence of educational equity in each area.

It makes some areas in district began build themselves, one of which is Serang District. Some teachers in district have also started using gadgets in everyday life even though there are several obstacles to using gadgets such sophisticated smartphone or other gadget.

(B) Design and development

Many educational ICT-based products have been developed to empower teachers to optimize the use of their own ICT devices for use in mathematics teaching and learning. We have developed different kit to others after the survey. Two important things in Mathematics Teaching and Learning, Mathematical Learning Resources and Learning Designs with purpose that the

Mathematics Teachers to be equipped with technology. Two android applications already developed. Researchers hired computer programmers to develop the application. The applications are developed to response survey results. The first application, called Guidelinks, deals with mathematical learning resources, while the second, called LDSoft, deals with learning designs.

The android application is still need additional files, called learning resources and learning design maps to works as expected. The files being developed and scheduled to be completed for use in implementation with mathematics teachers in Banten Province, Indonesia. The use of these applications is illustrated in Annex. [Figure 2](#)

Main function of the kit is to document the design of mathematical teaching and learning experiences, especially in the three main components of learning design: resources, tasks, and supports. The feature would be enabling mapping of resources to a national curriculum in Indonesia. The outcome of this mapping would be a greater access for teachers in developing countries to available and relevant mathematical learning resources on the internet. Another feature is the documentation of the design of mathematical teaching and learning experiences, which would be related to teaching methods. This feature would be related on how to document teaching and learning experiences. In addition, the time-based activities of the teachers and students in one unit of learning also proposed to be able to be documented [Figure 3](#).

3.3. Schools' implementation and teachers' response

Field Research with mathematics teachers in their natural setting environment (schools and areas) for implementation of the android applications already developed. The sub districts consist of Serang City, Serang Regency, Cilegon City, Tangerang City, Tangerang Regency, and Pandeglang Regency This research was conducted toward various age groups of teachers to find out how the products work in its natural setting environment. Through the various age groups assessments are expected to show usability of the learning designs mobile application LDSoft and learning resources mobile application Guidelinks and its XML-based maps.

Figure 2. Beta version of android application to deal with learning resources.

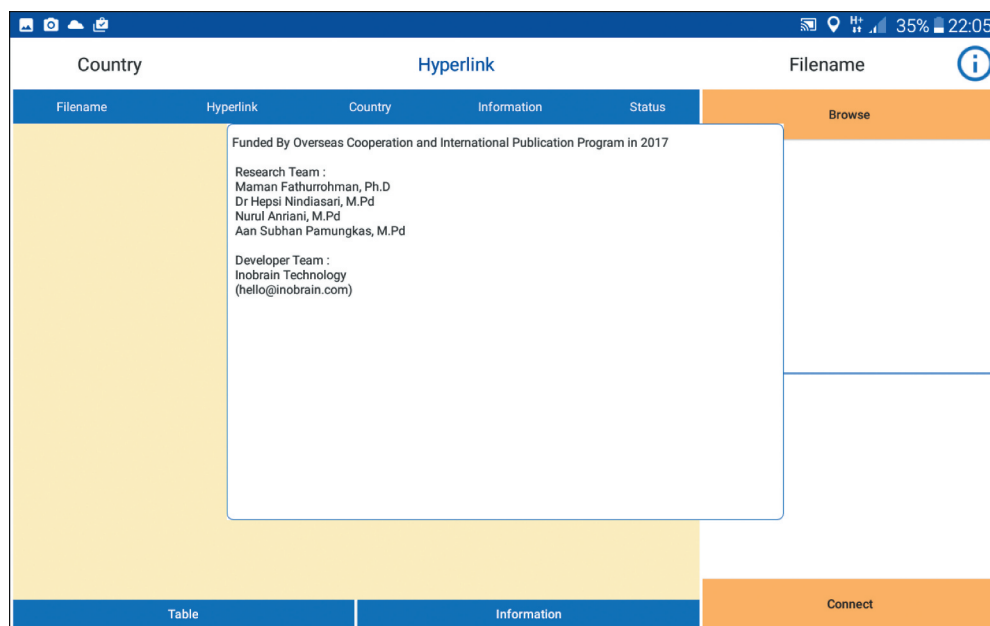


Figure 3. Beta version of android application to deal with learning designs.

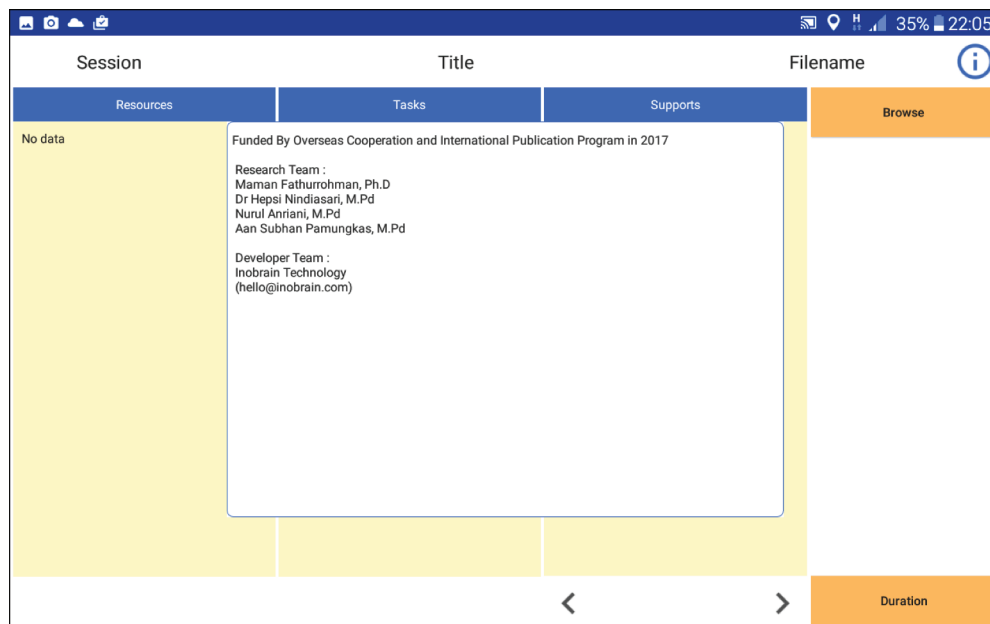


Table 11. User response based on age group

No	Age Group	Respondents	Percentage
1	Young Adult (18–25)	7	83,12%
2	Adulthood (25–40)	24	82,92%
3	Middle Age (40–60)	15	87,66%

Based on the user response as displayed in [Table 11](#), therefore, it can be concluded that learning resources and learning designs mobile applications and its maps in state of category “very good” and can be working as expected in its natural setting environment.

3.4. Benefit for COVID-19 pandemic or endemic situation

The spread of COVID-19 pandemic, started around March 2020 in Indonesia has resulted to many schools closed. The process of teaching and learning has forced to implement through online school from home. The implementation of online school from home requires teaching resources to be internet-accessible and learning design to be personalized. These situations benefit the use of android applications Guidelinks that can share internet-accessible resources and LDSoft that can share teachers learning designs. The optimal use of these applications will be in internet-connected environment. In the term of remote learning due to some circumstances, such as in this COVID-19 Pandemic, theoretically the teachers can use the android applications of GuideLinks and LDSoft to support their remote teaching and learning. Accessing the internet-based resources facilitated by the application will open access of students.

3.5. Broader impact

The developed kit during this project is intended for use in this situation, to empower teachers using their own internet-connected devices to use these internet accessible mathematical learning resources and to share mathematical learning designs. Learning design itself is intended to be available to be share to other teachers for practical use or modification. The availability of technology-based kit for mathematics teachers will support a better mathematical instructional delivery. The implementation could lead what to people say as Bring Your Own Devices (BYOD) to

school for use in mathematics teaching and learning. Feasibility can be achieved through meeting the needs and capability.

4. Conclusion

Mathematics teachers ICT readiness can be empowered by optimizing the use of their own devices in internet-connected environment by providing android applications to share internet-accessible resources and learning designs. To successful roll out the android applications of GuideLinks and LDSoft, teachers must be equipped with basic ICT skills and their own android devices. By the time internet-connected environment, where and when teachers always connected to the internet, without barrier of time, internet quota, and location, achieved by many societies, in classes, schools and their homes the potential of successful implementation will be higher.

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Disclosure statement

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Annex. How the android applications works?

The applications developed, Guidelinks to facilitate the use of internet-accessible resources and LDSoft to document and share teachers' learning designs. This section provide information on how the android applications its XML-based maps works:

(1) Guidelinks

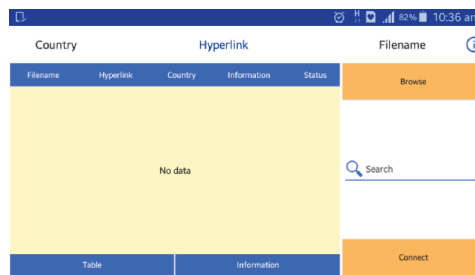
a Logo Display of Guidelinks, b Start Display of Guidelinks, c Learning Resources XML-based Maps, d Main Display of Guidelinks, e Learning resources display.

The opening display of Guidelinks shows the application icon (a). Then, it appears the initial appearance of Guidelinks. It's a table with five main columns are Filename, Hyperlink, Country, Information, Status,

Figure A1. How to use guidelinks.



a Logo Display of Guidelinks



b Start Display of Guidelinks



c Learning Resources XML-



d Main Display of Guidelinks



e Learning resources display

Information, Status, and Browse and Connect menu (b). To be able to find the link of learning resources that recommended by developer, the users click Browse menu to find and choose learning resources XML-based maps (c). Then, it appears the description of link of learning resources (d). The users can continue to see the content of learning resources by click one of the links of learning resources on the table, then click Connect menu. Then, Guidelinks appears the content of learning resources and it's ready to use by the users (e).

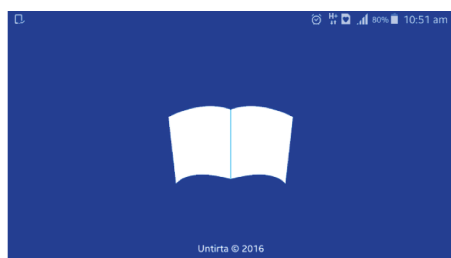
(2) LDSoft

a Logo Display of LDSoft, b Start Display of LDSoft, c Learning Resources XML-based Maps, d Main Display of LDSoft, e Duration Menu Display of LDSoft.

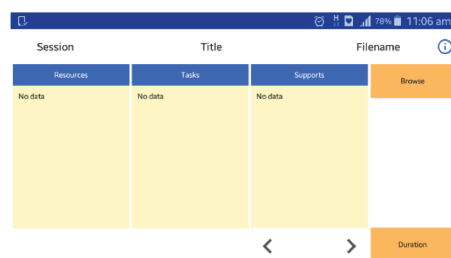
The opening display of LDSoft shows the application icon (a). Then, it appears the initial appearance of LDSoft. It's a table with three main columns are Resources, Task, Supports, and Browse and Duration menu (b). The learning design components of tasks, resources, and supports, provided a useful framework for participants to focus on the key aspects of a learning design. To be

Figure A2. How to use LDSoft.

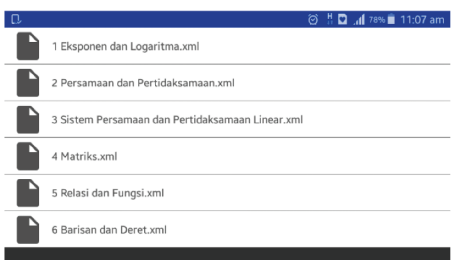
2. LDSoft



a Logo Display of LDSoft



b Start Display of LDSoft



c Learning Resources XML-



d Main Display of LDSoft



e Duration Menu Display of LDSoft

able to find the learning designs that recommended by developer, the users click Browse menu to find and choose learning design XML-based maps (c). Then, it appears the description of the learning design in the table and it's ready to use by the users (d). The users also can continue to see the duration of the learning designs by click the Duration menu (e).



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