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Modifiable and Sharable Electronic Maps of Mathematical Learning
Resources for Use in Developing Countries: A Case Study of
Bojonegara Sub District, Indonesia

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Modifiable and Shareable Electronic Maps of Mathematical Learning Resources for Use in Developing Countries: A Case Study of Bojonegara Sub District, Indonesia

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Abstract: Teaching and learning of mathematics are integral parts of societies in many countries in the world. The fundamental or core nature of mathematics, its compulsory acquisition, requires a high quality of mathematics learning experiences. Moreover it is highly desirable that the emergence of new technology positively influences learning experiences in mathematics. Since 81.5 % of countries in the world belong to developing countries, it is important that technology-based learning experiences are implemented in these countries. Based on observation in Bojonegara Sub District, Indonesia, a prototype of modifiable and shareable electronic maps and its concept and design would be useful for teachers to easily access then either download or use mathematical learning resources. This technology would be suitable and useful for use in developing countries.

Introduction

Teaching and learning of mathematics are integral parts of societies in many countries in the world. Many governments have programs or initiatives to introduce mathematics in formal education through national curriculum. Moreover some governments, for example Ministry of National Education Republic of Indonesia, have regulating standards requiring competency in mathematics to pass elementary and secondary school. The importance of mathematics continues through tertiary education, not only in mathematics undergraduate or postgraduate program, but also in other discipline programs where subjects in mathematics become courses requirements for the degrees in these programs. The fundamental or core nature of mathematics, its compulsory acquisition, requires a high quality of mathematics learning experiences, not only in elementary schools, but also in secondary and tertiary level. It is highly desirable that the emergence of new technology positively influences learning experiences in mathematics.

English (2008) emphasizes three priorities in mathematics education research: 1. Life-long democratic access to powerful ideas, 2. Advances in research methodologies, and 3. Influences of advanced technologies. The first priority emphasizes the need to create a life-long democratic access to powerful ideas of mathematics. This priority relates to mathematical learning resources in how the resources can be used by students to access ideas of mathematics. The third priority emphasizes there is a need to consider the influences of advanced technologies in mathematics teaching and learning experiences. Related with the third priority, Lockyer (2009) has stated that designing high quality, technology-supported learning experiences is significant challenge for educators.

However, there are different conditions between Information and Communication Technology (ICT) infrastructures, facilities, and resources in high technology countries, which are usually advanced economies countries, with ICT condition in emerging and developing countries. For example, as shown in Table 1, proportion of number of internet user.

Table 1: People with internet access in some countries

No	Name of Country	Internet user (per 1,000 population)	Percentage
1	United States of America	663	66,3%
2	Japan	587	58,7%
3	Australia	540	54,0%
4	Indonesia	65	6,5%
6	Nigeria	14	1,4%

Source: World Data, Encyclopedia Britannica Ultimate Reference Suite 2010

These differences shall be considered in research and education that are related to technology-based learning experiences. According Batane (2006), computer and internet access are scarce in developing countries. Furthermore insufficient number of computers in schools is major problems plaguing most developing regions. Moreover, according to IMF (2010), there are 34 countries in advanced economies and around 150 emerging and developing countries. This data shows 81.5 % countries in the world belong to developing countries. Since 81.5% countries in the world belong to developing countries, it is important that the technology-based learning experiences to be implemented in these countries.

The Study

Implementation of technology-based learning experiences requires information regarding real and perceived ICT infrastructures, facilities, and resources in developing countries. In order to get this information, observation in developing country was needed.

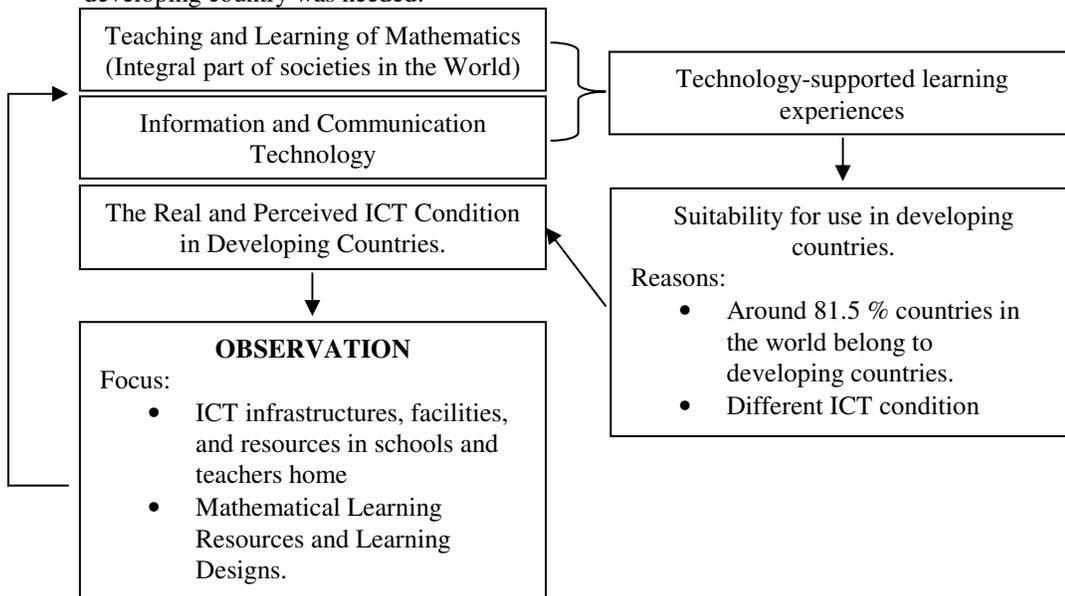


Figure 1: General Concept of Technology-Based Learning Experiences Implementation in Developing Countries



Figure 2: Location of Bojonegara Sub District, Indonesia

One accessible area in developing country and of interest to the researchers was Bojonegara Sub district, Banten Province, Indonesia. Map of this area is showed in Figure 2. Bojonegara is located in coastal region of Java Island, Indonesia. Geographically, Bojonegara is dominated by rural areas. There are a lot of farmers and fishermen in this region. Number of schools and teachers in Bojonegara Sub District are presented in Table 2.

Table 2: Registered Schools Teachers in Bojonegara Sub District, Indonesia (August 2010)

No	Level	Number of Schools	Number of teachers	Percentage
1	Elementary School	22	313	53.50
2	Junior High School	9	194	33.16
3	Senior High School	3	78	13.33
	Total	34	585	100.00

Source: Ministry of National Education, Republic of Indonesia. (August 2010)

To facilitate comparisons and to have a sufficiently large sample the researchers took a higher proportion from the smaller cohorts. Researchers also consider time duration and an access to schools in choosing the number of schools to sample.

Following is an estimation of the number each school type.

- Around 1/7 of number of elementary schools teachers ($1/7 \times 313 = 45$ teachers)
- Around 1/5 of number of junior secondary schools teachers ($1/5 \times 194 = 39$ teachers)
- Around 1/2 of number of senior elementary schools teachers ($1/2 \times 78 = 39$ teachers)

The teachers were determined based on a simple random sampling scheme within each type.

Below here are topics of ICT infrastructures, facilities, and resources that are observed.

Table 3: Focus of observation

No	Focus of Observation			
	ICT Condition at School	ICT Condition at Home	Learning Resources	Learning Designs
1	Condition of computer laboratory and its use on teaching and learning	Condition of computer and its use for teaching and learning	Current condition of available learning resources	Current condition of learning designs and its share in the school
2	Condition of notebooks and projectors and its use on teaching and learning	Condition of printer and scanner and its use for teaching and learning	Types of learning resources at schools	Teachers' opinion on implementation of technology-based learning designs and its potential problems
3	Condition of internet access and its use on teaching and learning	Condition of internet access and its use for teaching and learning	Teachers' opinion of implementation of technology-based learning resources and its potential problems	Teachers' initiative on developing learning designs
4	Condition of official website or blog and its use on teaching and learning	Condition of personal website or blog and its use for teaching and learning	Teachers' experiences on creating, modifying, and sharing learning resources	Learning resources of technology-based learning designs
5	IT Staffs	IT Assistance		
6	Internet access using hand phone in schools	Internet access using hand phone at home		
7	General information of ICT at schools	Frequently used software		
8		General information of ICT at home		

Instruments of observation consist of questionnaires package, guidelines for unstructured interviews, and video recorder for documentation (photo and video). For each teacher, genders, working experiences, academic degree & field of study, and training in ICT were assessed in relation to ICT Condition at school & home, and the learning designs & resources they had access to or experiences. Further details explained in table 3.

Findings

Observation Results

The observation conducted between October 2010 to February 2011 with several weeks of breaks around last December and early January. During the observation, total of 220 questionnaire packages were distributed to teachers, however only 119 of them were filled and returned. A total of 12 teachers were interviewed, with five of these interviews video recorded. Several head masters welcomed and allowed researcher to visit their schools and make a documentation of ICT Infrastructures and facilities, while the others did not allow the researcher to do that. These headmasters, however filled questionnaires packages for teachers, 10 of them returned the questionnaires, the remaining 1 did not.

The general information of respondents is reported in Table 4.

Table 4: Responden Identity based on School Level

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Elementary School	41	34.5	34.5	34.5
	Junior Secondary School	51	42.9	42.9	77.3
	Senior Secondary School	27	22.7	22.7	100.0
	Total	119	100.0	100.0	

The numbers of teachers as respondents are not exactly same sought as calculated at sample estimation, with less than in the senior secondary and more in the junior secondary. However these were considered viable number in terms of completing the project and representing the school condition.

ICT facilities are being developed in this region. In recent years, a lot of ICT infrastructures and facilities have been developed in this region. BTS (Base Transceiver Station) Towers delivering wireless signal for hand phone and internet connection have been constructed in this region. This condition is good for students and teachers because the wireless signal of hand phone and internet must be very good for their school, however it may be dangerous because a radiation of BTS may has a bad effect for them in the long term.



Figure 3: Location of BTS Towers Near Schools

ICT in Schools

In Elementary Schools, computer and related facilities are only used for administration purposes, for example writing letters or administration reports, not for teaching and learning. This was supplied by the education office for school administration purposes not to support teaching and learning processes. Some elementary schools also have TV and related electric equipment (such as CD/DVD players).



Figure 4: Computer and others ICT Facilities

In Junior and Senior High Schools, most of schools have computer laboratory for teaching and learning process.



Figure 5: Computer Laboratory

Some classes are also equipped with TV. However as determined by the visits and interviews, usually the TV was rarely used by teachers.



Figure 6: A Class with a TV

Government Programs

Table 5: Government Responsibility

Level	Government	Education Affair
Country	Republic of Indonesia	Ministry of National Education
Province	Banten Province	Education Office Province Branch
District	Serang District	Education Office District Branch
Sub District	Bojonegara	Education Office Sub District Branch

As shown in Table 5, Education affair in Bojonegara Sub District is directed by Education Office Sub District Branch. To support ICT for Education, the Education Office at this branch has several programs usually in

supplying ICT facilities and equipment for schools, and training teachers or staff that will use these facilities. The Education office usually supplied computers, printers, scanners, and internet connection to schools through cooperation with several companies. In national level, Ministry of Education also has several initiatives related to ICT. These initiatives related to curriculum and educational contents for example BSE Program (Electronic School Books Program) that can be used for free by teachers and students.



Figure 7: A screenshot of Electronic Text Books (Provided by Government)

These electronic books are available in PDF format. There are various of books that can be used by students and teachers from Class I (The first stage of formal education) of Elementary Schools to Class XII (last stage before university level) of Senior High School. Copyright of these books is owned by Ministry of National Education and the contents of these books are evaluated and monitored by the Ministry of National Education. Teachers have explained through questionnaires how they use these facilities for teaching and learning.

Table 6: Cross Tabulation Between Level of School and the Use of Computer Laboratory

			SCHOOL - Using Computer Laboratory for Teaching and Learning			Total
			No	1 to 2 times per month	3 to 5 times per month	
SCHOOL – Level	Elementary School	Count	41	0	0	41
		% within SCHOOL - Level	100.0%	.0%	.0%	100.0%
	Junior Secondary School	Count	20	9	2	31
		% within SCHOOL - Level	64.5%	29.0%	6.5%	100.0%
	Senior Secondary School	Count	15	3	1	19
		% within SCHOOL - Level	78.9%	15.8%	5.3%	100.0%
Total		Count	76	12	3	91
		% within SCHOOL – Level	83.5%	13.2%	3.3%	100.0%

Table 6 reveals that only a few of teachers who usually use computer laboratory for teaching and learning. Most of them did not use the computer laboratory for teaching and learning or only use it for a limited time only. Similar outcomes occurred in relation to the use of internet for teaching and learning, as explained in Table 7.

Table 7: Cross Tabulation Between Level of School and the Use of Internet Access

			SCHOOL - Using Internet Access for Teaching and Learning				Total
			No	1 to 2 times per month	3 to 5 times per month	More than 10 times per month	
SCHOOL – Level	Elementary School	Count	41	0	0	0	41
		% within SCHOOL - Level	100.0 %	.0%	.0%	.0%	100.0%
	Junior Secondary School	Count	26	7	1	1	35
		% within SCHOOL - Level	74.3 %	20.0%	2.9%	2.9%	100.0%
	Senior Secondary School	Count	24	2	0	1	27
		% within SCHOOL - Level	88.9 %	7.4%	.0%	3.7%	100.0%
Total		Count	91	9	1	2	103
		% within SCHOOL - Level	88.3 %	8.7%	1.0%	1.9%	100.0%

According to the interviews, several senior and junior secondary schools have their own computer notebooks. Some of them bring it to the school for their own purposes. Teachers also explained that most of them using internet to download educational content for use in teaching and learning. It is means that the internet sometimes becomes their alternative source of teaching materials, because they find many things than are useful for their teaching and learning in the class. Interestingly, several teachers also have internet connection from their own mobile phones, and most of them frequently access internet using it. It is means that they know that internet is useful and they know how to use it especially to get learning resources.

Resource are defined as a source of help or information (Oxford Dictionaries), learning defined as the acquisition of knowledge or skills through study, experience, or being taught (Oxford Dictionaries), and Mathematical defined as relating to mathematics (Oxford Dictionaries). Based on above definitions, Mathematical Learning Resources are sources of information that can be used for the acquisition of knowledge or skills related to mathematics through study, experience, or being taught.

The Ministry of National Education, Canada has its own definition of learning resources:

Learning Resources are defined as information, represented and stored in a variety of media and format that assist student learning as defined by provincial or local curricula. This includes but is not limited to, materials in print, video, and software formats, as well as combinations of these formats intended for use by teachers and students.

In this article, Mathematical Learning Resources are defined as sources of information, represented in a variety of media and format that can be used to assist student learning through study, experience, or being taught, as defined in national curricula, to acquisition of knowledge or skills related to mathematics. Recent studies in Mathematical Learning Resources, such as Langrall, Mooney, Nisbet, & Jones (2008), Rojano (2008), and Mamona-downs & Downs (2008) explained about the access to ideas of mathematics for elementary, secondary, and tertiary level students. In general ideas of mathematics are proposed to be included in mathematical learning resources for elementary, secondary, and tertiary level education.

In general, based on results of observation several important findings about ICT infrastructures, facilities, and resources were gathered. It is now known that computer laboratory and internet access only available in junior and senior secondary schools. Most of the teachers access and use the internet to gather educational content for use

in teaching and learning. The World Wide Web is one of the sources of learning resources. However because there are too many learning resources in the World Wide Web, one way of assisting teachers involves mapping the educational contents of learning resources in the World Wide Web for use in education, especially for teaching and learning in Bojonegara Sub District. It would be useful for teachers and enabling them to get appropriate learning resources easily.

Concept and Development of Electronic Maps

The development of electronic maps was motivated by condition that there are millions of websites in the World Wide Web, including websites that contain mathematical learning resources, but only a few of them (that are popular or frequently appear in upper rank of search engine machine) can be accessed. The development of this tool would enable teachers from developing countries, as their condition are explained in observation results, to access then either download or use educational contents for use in their classes. The use of mathematical learning resources in the World Wide Web for teaching and learning supported by Kissane who provided six categories of opportunities afforded by Internet Access for learning mathematics.

Table 8: Comparison Between Earth and World Wide Web

Earth	The World Wide Web
Place	Website
Place Address	Web address
Data and Information of place	Data and information of website
Map or Atlas	Not Available

The development is also motivated by the comparison of the earth and the World Wide Web as shown in table 8 (above). While there are equivalencies between place address and web address for example, there is no equivalence in the World Wide Web to the map or atlas of the Earth. A map or atlas that presents the earth will be useful in finding a specific location.

A prototype of this tool will be based on a file of Microsoft Access Database as a template of the map, and the visual basic application as a reader of this file. The application (reader) will read the selected file, and then teachers choose from the website data as supplied in the map. It is recommended that the map is based on geographic location of the world. Teachers also can use a catalogue and a search function provided in the application (reader) while working with the map. If they found interesting website of mathematical learning resources that are needed, they only need to click a button in application to visit this website (no typing a long web address, or using a search engine).

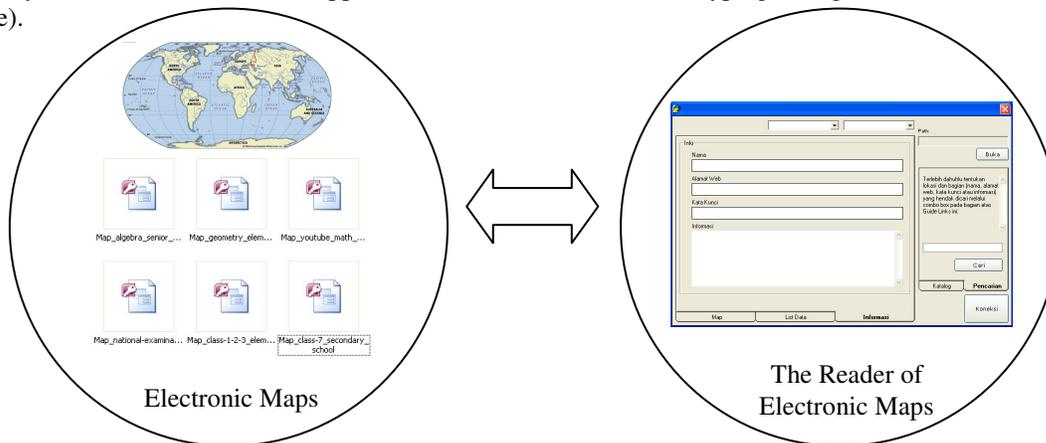


Figure 8: Concept of Modifiable and Shareable Electronic Maps for Education

The template of electronic maps itself could be modified by teachers. No programming skill is required to create and modify this template. They can create their own maps of learning resources, or modify existing ones, then share it with other teachers. It would enable them to work together and share knowledge. Beside commercial version

of Microsoft Access, the modification of this template also can be done using available freeware version of access database viewer applications. However the use of these maps still needs a reader application program.

As shown in Figure 9. Without electronic maps, each teacher will have different access to mathematical learning resources in the World Wide Web depend on their own knowledge and experiences on accessing it through internet. However with electronic maps of mathematical learning resources, they will have a common and standard great access to mathematical learning resources in the World Wide Web. They also could share their own knowledge to others.

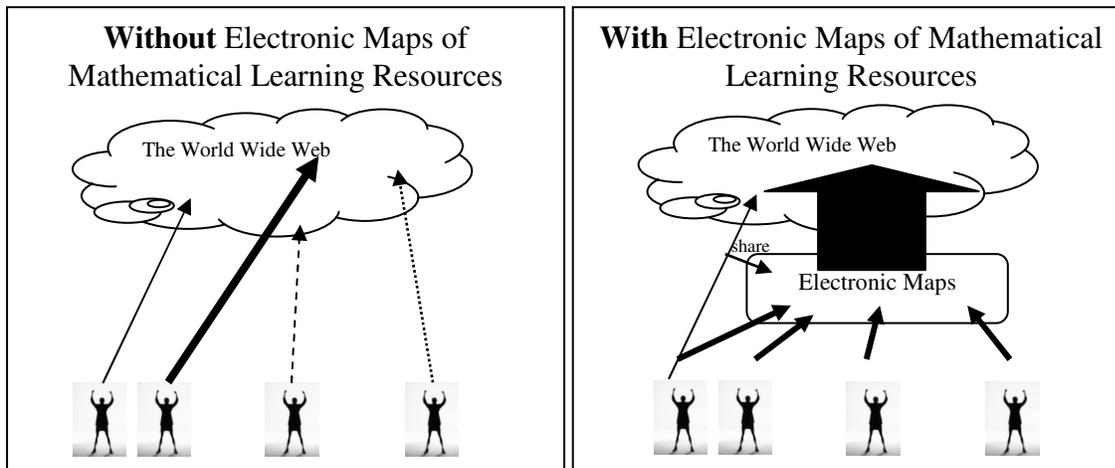


Figure 9: An Illustration of Condition Without and With Electronic Maps

The implementation of this technology is suitable with capability of teachers in Bojonegara Sub District, Indonesia. Moreover, the technology also suitable with ICT condition in teachers school and home. Since ICT condition in Bojonegara Sub District, Indonesia is nearly same with ICT condition in other regions of developing countries, this technology would be suitable and useful for teachers in these countries to easily access then either download or use mathematical learning resources for their classes.

Conclusions

A prototype of modifiable and shareable electronic maps and its concept and design based on observation in Bojonegara Sub District would enable teachers in developing countries to easily access, then either download or use mathematical learning resources in the World Wide Web. This technology would be suitable and useful for use in developing countries.

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