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Addressing the Needs of a Developing Nation: Electronic Maps of Mathematical Learning Resources Accessible Via the Internet

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Teaching and learning of mathematics are integral parts of societies throughout the world. The fundamental or core nature of mathematics, its compulsory acquisition, requires high quality mathematics learning experiences. Moreover it is highly desirable that the emergence of new technology positively influences learning experiences in mathematics. Since 81.5 percent of countries in the world belong to developing countries, it is important that technology-based learning experiences are implemented in these countries. Based on a survey in Bojonegara Sub District, Indonesia, a prototype of modifiable and shareable electronic maps has been developed. This product would be useful for teachers mapping mathematical learning resources in the Internet for easy access and download for use for teaching and learning. The teachers could also create, modify and share the maps with others.

INTRODUCTION

Teaching and learning of mathematics are integral parts of societies throughout the world. Many governments have programs or initiatives to introduce mathematics in formal education, through national curricula. Moreover some governments 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 programs, but also in other discipline programs where subjects in mathematics become course 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 at secondary and tertiary levels. As discussed by Forster (2006), technology should be considered in teaching and learning mathematics. It is highly desirable that the emergence of new technology positively influences learning experiences in mathematics.

English (2008) emphasizes three priorities for 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, the need to create a life-long democratic access to powerful ideas of mathematics, is consistent with the access and use of ideas of mathematics through student access of resources, by all people including those in developing nations. The third priority emphasizes the need to consider the influences of advanced technologies in mathematics teaching and learning experiences but as Lockyer (2009) states designing high quality, technology-supported learning experiences are significant challenges 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 when compared to ICT conditions in emerging and developing nations. For example, as shown in Table 1, the proportion of internet users differs greatly between countries. These differences need to be considered in research and education that is related to technology-based learning experiences. The Organization for Economic Co-operation and Development (2000) addressing the different ICT conditions between advanced economies countries and developing countries drew attention to the importance of ICT to both the economic and social development. The OECD discuss the priority of bridging what has come to be known as the “digital divide” (OECD, 2000: 3).

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%
5	Nigeria	14	1.4%

Source: World Data, Encyclopedia Britannica Ultimate Reference Suite 2010

According to the IMF (2010), there are 34 countries in advanced economies and approximately 150 classified as emerging and developing countries equating to 81.5 percent countries in the world. The digital divide between developed and developing countries has been considered by several researchers who created tools suitable for use across the divide. Examples include a Web server, that enable students to use the expensive laboratory equipment virtually, developed by Gonzales (2006), and the prototype IMMEDIATE, that provides a specialized e-learning environment for the PC which is more accessible and usable for students, developed by Johnsons (2006). Meanwhile, Beynon (2006) focused on and recommended computer related technology that is suitable for use in developing countries.

Research related to the introduction and use of technology has been conducted in regions of several developing countries. Olayi (1990) discussed components of mathematics curriculum for developing countries, Khan (2000) developed on-line distance learning in India, Mosquera (2001) gave examples as to how to use Internet resources in Colombia, Zhang (2003) addressed the current condition for teaching mathematics in primary schools in China while Mtetwa (2005) describe this for Zimbabwe, Goulden (2005) discussed issues in capacity building in Africa, Sanga (2006) developed and distributed the open courseware in South Africa, Batane (2006) reported on technology use in Botswana, Bada (2006) implemented E-Learning in Uganda, Hall (2009) developed guidelines for developing online courses in Oman, and Bower (2010) developed EDUWEBTV in Malaysia.

With such a high proportion of countries in the world being developing nations, it is important that mathematical learning resources and learning design representations be available and implemented in developing coun-

tries, so that the gap between developed and developing countries in education does not grow greater, leaving these countries comparatively more disadvantaged.

THE STUDY

To introduce technology-based learning experiences to teachers and students in developing countries requires information regarding real and perceived ICT infrastructures, facilities, and resources. In order to get this information, a survey in a locale of interest in the developing country Indonesia was undertaken. This locale was Bojonegara Sub District, Banten Province, Indonesia. Bojonegara is located in the coastal region of Java Island, Indonesia. Geographically, Bojonegara is dominated by rural areas. The General concept leading to this study are presented in Figure 1.

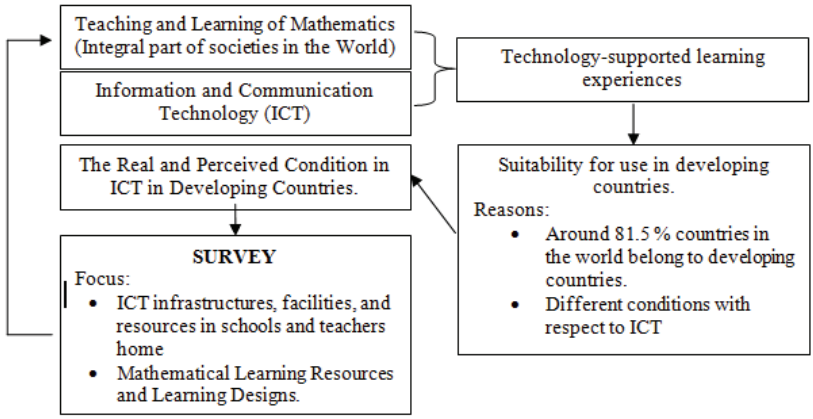


Figure 1. General Concept of Technology-Based Learning Experiences Implementation in Developing Countries.

Schools in Banten Province are classified as elementary years 7 to 12, junior high school years 13 to 15, and senior high school, years 16 to 18. The sample of schools chosen was drawn from a population of 34 schools and a total of 585 teachers as categorized 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 considered available time and access to schools in choosing the number of schools to sample.

Following is an estimation of the number each school type.

- 1/7 of number of elementary schools teachers (1/7 x 313 = 45 teachers)
- 1/5 of number of junior secondary schools teachers (1/5 x 194 = 39 teachers)
- 1/2 of number of senior elementary schools teachers (1/2 x 78 = 39 teachers).

The teachers to sample were selected from a total number of teachers. They were selected based on a simple random sampling scheme within each cluster (school level). For each teacher, gender, working experience, academic degree and field of study, and training in ICT was assessed. In addition to ICT conditions at school and at home, the learning designs and resources they had access to or experienced were examined. The foci in relation to conditions are presented in Table 3. To gather this information several survey instruments were used including a questionnaire package, guidelines for unstructured interviews, and a video recorder for documentation (photo and video). The survey instruments for headmasters and teachers were the same

Table 3
Focus of survey

No	Focus of Survey			
	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 computer 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		

FINDINGS

Survey Results

The survey was conducted between October 2010 and February 2011 with several weeks of breaks around the end of December and early January. During the survey, a total of 220 questionnaire packages were distributed to teachers, however only 119 of them were filled and returned with a response rate of 54 percent. A total of 12 teachers were interviewed, with

five of these interviews video recorded. Ten head masters welcomed and allowed the researcher to visit and document ICT infrastructure and facilities in their schools. Only two principals did not allow the researcher access to the school or teachers.

The source of respondents according to school level is reported in Table 4.

Table 4
Questionnaire Responses by School Level

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

The numbers of teachers as respondents was not exactly same as calculated at sample estimation, with less responding from the senior secondary level and more responding from junior secondary. However these were considered viable number in terms of completing the project and representing schools' ICT conditions.

In recent years, a lot of ICT infrastructure and facilities has been developed in this region of Banten Province. BTS (Base Transceiver Station) Towers constructed in this region now deliver wireless signal for hand phones and Internet connection enhancing communication both within and outside the school district.

BTS (Base Transceiver Station) Tower near schools

Figure 2. Location of BTS Towers near Schools.

ICT in Schools

In Elementary Schools, computer and related facilities are used only for administrative purposes, such as writing letters or administration reports; they are not for teaching and learning. The equipment 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 3. Computer and others ICT Facilities.

In Junior and Senior High Schools, 66.7 percent of schools have at least computer laboratory for teaching and learning.

Figure 4. Computer Laboratory.

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

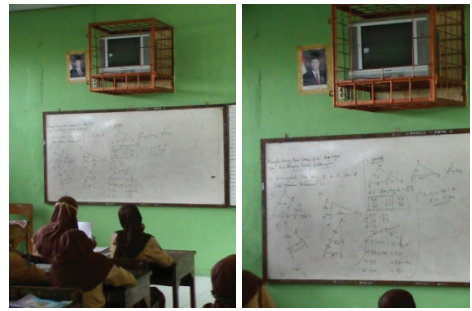


Figure 5. A Class with a TV.

The Availability of Mathematical Learning Resources

As shown in Table 5, educational affairs in Bojonegara Sub District are managed by Education Office Sub District Branch. To support ICT for Education, the Education Offices at this branch has several programs to supply ICT facilities and equipment to schools, and to train teachers or other staff that will use these facilities. The Education Office usually supplies computers, printers, scanners, and Internet connection to schools in cooperation with several companies.

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

At the national level, the Ministry of Education has also initiated several initiatives related to ICT. These initiatives relate to curriculum and educational content, for example the BSE (*Buku Sekolah Elektronik* which refers to Electronic School Books, Refer Figure 6) Program is an electronic book provision program, that can be used for free by teachers and students.

Figure 6. A screenshot of Electronic Text Books (Provided by Government).

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

The supply of government electronic resources is closely related to the use of computers and Internet by teachers. A cross-tabulation of computer use and school level provided in Table 6 reveals that only 16.5 percent of teachers usually use computer laboratories for teaching and learning while the remaining 83.6 percent of them either did not use the computer laboratory for teaching and learning or if they did, they used it for a limited time only.

Table 6

Cross Tabulation Between Level of School and the Use of Computer Laboratory

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

Similar outcomes of little or no use were found in relation to the use of Internet for teaching and learning, as displayed 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	Elementary School	Count	41	0	0	0	41
		% within School		.0%	.0%	.0%	100.0%
	Junior Secondary School	Count	26	7	1	1	35
		% within School	74.3%	20.0%	2.9%	2.9%	100.0%
	Senior Secondary School	Count	24	2	0	1	27
		% within School	88.9%	7.4%	.0%	3.7%	100.0%
Total		Count	91	9	1	2	103
			88.3%	8.7%	1.0%	1.9%	100.0%

The Accessibility of Mathematical Learning Resources

According to the interviews, 53 percent of senior and junior secondary schools teachers have their own computer. Ten percent of them bring the computer to school for their own purposes. Ten percent of teachers reported using the Internet to download educational content for use in teaching and learning. In this manner the Internet sometimes becomes their alternative source of teaching materials, because they find many things than are useful for classroom teaching and learning. Interestingly, 59 percent also have Internet connection from their own mobile phones, and 20 percent of them access the Internet more than 5 times per day. These teachers know that the Internet is useful and they know how to use it, especially to get learning resources. The use of other learning resources available in the Internet greatly expands possibilities compared to use only of resources created by teachers and the government.

The Ministry of National Education, Canada (1999) has defined learning resources: *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 paper, *mathematical learning resources* are defined as sources of information, represented in a variety of media and formats that can be used to assist student learning through study, experience, or being taught, as defined in national curricula, for the acquisition of knowledge or skills related to mathematics. Recent studies of mathematical learning resources, such as Langrall, Mooney, Nisbet, & Jones (2008), Rojano (2008), and Mamonadowns & Downs (2008) suggested the need for elementary, secondary, and tertiary level students to have access to ideas of mathematics are embedded in mathematical learning resources.

Based on the results of this survey, several important findings about ICT infrastructures, facilities, and resources in this developing country were gathered. It is now known that computer laboratory and Internet access is only available in junior and senior secondary schools. The World Wide Web is one of the sources of learning resources. Approximately 10 percent the teachers access and use the Internet to gather educational content for use in teaching and learning and more would like to. Because there are many mathematical learning resources in the World Wide Web, one way of assisting teachers especially for teaching and learning in Bojonegara Sub District involves mapping the educational contents of mathematical learning re-

sources in the World Wide Web. Sherman (2002) refers to hidden resources on the web as the invisible web. Electronic maps, shared between teachers would be useful for teachers, enabling them to identify and access appropriate mathematical learning resources easily. For learning designs, since the teachers would like to use other teachers learning designs, it is better that there is a circulation of a good learning design between teachers.

Concept and Development of Electronic Maps

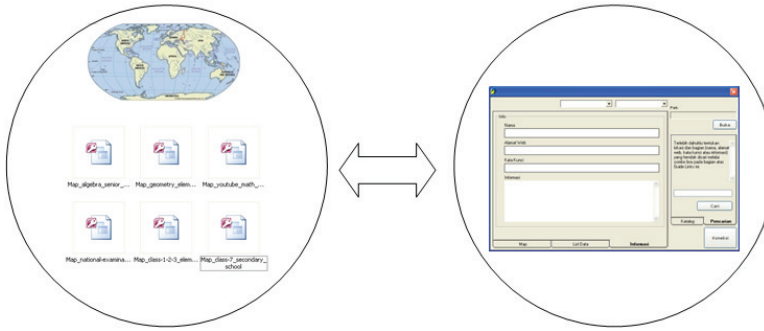
The development of electronic maps was motivated by the millions of websites in the World Wide Web, which includes websites that contain mathematical learning resources, of which only a few (that are popular or frequently appear in upper rank of search engine machine) can be readily accessed. The development of this sharing tool would enable teachers from developing countries, to access, download and use educational content for use in their classes. Kissane (2011) provided six categories of opportunities for use by students and five categories for use by teachers for teaching and learning when using mathematical learning resources located in the World Wide Web. According to Kissane (2011) the six categories for students are: 1). Interactive resources, 2). Worthwhile reading materials, 3). References materials, 4). Communications among students and others, 5). Problem solving, and 6). Web quest, while the five categories for teachers are: 1). Direct lesson materials or ideas, 2). Official communication regarding the curriculum or the governance of education within their environtment, 3). Professional engagement, 4). Commercial element, yet still opportunities that were previously inaccessible, and 5). Local use within a school or school district.

The development was also motivated by the comparison of the earth and the World Wide Web as shown in table 8. 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.

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 proposed concept for map of resources in the Internet involves a map and reader as displayed in Figure 7.



Electronic Maps

The Associate Reader of Electronic Maps

Figure 7. Concept of Modifiable and Shareable Electronic Maps for Education.

The current prototype of this tool is based on an MS Database file that provides a template of the map and the visual basic application that is an associate reader of this document. The associate reader reads the selected file, and then teachers choose to view from the website data as supplied in the map. It is recommended that the map be based on geographic location of the world. Teachers can also use a catalogue and a search function provided in the application (associate reader) while working with the map. If they found an 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).

The template for electronic maps can be modified by teachers. They can create their own maps of learning resources, or modify the existing ones, then share them with other teachers. This enables them to work together to share knowledge. It is also feasible that at an institutional level that maps be created that are aligned with curricula. Beside a commercial version of Microsoft Access, the modification of this template also can be accomplished using available freeware or open source versions of Access database viewer applications, such as Open Office. However the use of these maps still requires an associate reader application program.

The Use of Electronic Maps of Mathematical Learning Resources in the Internet

Electronic maps of mathematical learning resources in the Internet are intended for teacher use. Using these maps teachers can easily locate and visit mathematical learning resources in the Internet for download or use. Furthermore, teachers may share the electronic maps with students, so they can also easily locate and visit sites for selected mathematical learning resources, students can then self-learn using the learning resources at the web sites selected by their teacher.

Many web sites have rich mathematical learning resources, not only in the form of text or writing, but also in mathematical simulations and videos, which are of interest to students. This targeted rich variety can enhance students' mathematical independent learning experiences.

In this study, the use of Electronic Maps was implemented through collaborative research with mathematics teachers in Bojonegara Sub District, Indonesia. The teachers were selected from a group of teachers who participated in a previous survey. The ICT Skills and school ICT facilities were considered when choosing the teachers to sample. To facilitate comparisons between school levels, a total of 12 mathematics teachers, (4 mathematics teachers from each level) were invited to participate and be interviewed.

For each teacher, their genders, grade of teaching class, ownership and type of computers to be used in the school and home, and their satisfaction with and evaluation of components of electronic maps of mathematical learning resources in the Internet were gathered. Further details regarding teacher's satisfaction and evaluation of mapping components is revealed in Table 9. To gather this information several instruments were used; a questionnaires package, guidelines for interviews, and video recorder for documentation (photo and video).

An Electronic map is a file, while the associate reader is an application to read and display contents of the electronic maps appropriately. The Electronic map contains the information that will be represented as a map in the associate reader, thus the file is modifiable and shareable as long as it is not password protected. The associate reader needs to be installed on teachers' computer before it can be used. This reader has a catalogue and a search function. The design of the prototype of electronic maps of mathematical learning resources in the Internet is provided in the native language of participants (Bahasa Indonesia; the Indonesian language).

Table 9
Satisfaction & Evaluation Components of the Electronic Maps

Satisfaction Components	Evaluation Components
Electronic Maps 1. Idea 2. File Structure 3. Characteristics a. Database Structure b. Entry Data c. Modifiable and Shareable ability 4. Function 5. Innovation 6. Implementation **The Associate Reader of Electronic Maps** 1. Idea 2. Layout of Software 3. Characteristics a. Connection to Electronic Maps b. Catalog and Searching Facilities c. One button click to visit selected web site 4. Function 5. Innovation 6. Implementation	1. Easy to use 2. Appropriate to current ICT conditions 3. Beneficial for a. Teachers b. Students c. School d. Education office and community 4. Institutionalization a. Implementation b. Impact c. Self-managed by teachers for a long term

As illustrated in Figure 8, the step by step use of electronic maps is explained as follows:

1. The template of electronic maps is designed by researchers. Using this template teachers can create their own electronic maps of mathematical learning resources in the Internet.
2. After the associate reader is installed in the teacher's computer, the reader can be use to connect to a number of electronic maps.
3. After selecting one electronic map, the map will be displayed in the associate reader. Teachers can browse the map and view the list of data provided.
4. If needed, for example when the map contains a large amount of information, teachers can use catalog and searching functions to explore the map.
5. Teachers can read key words and information related to selected web site using the tab provided.
6. Teacher click the button provided to visit the selected web site. This button can be use several times as long as the map is still in use.

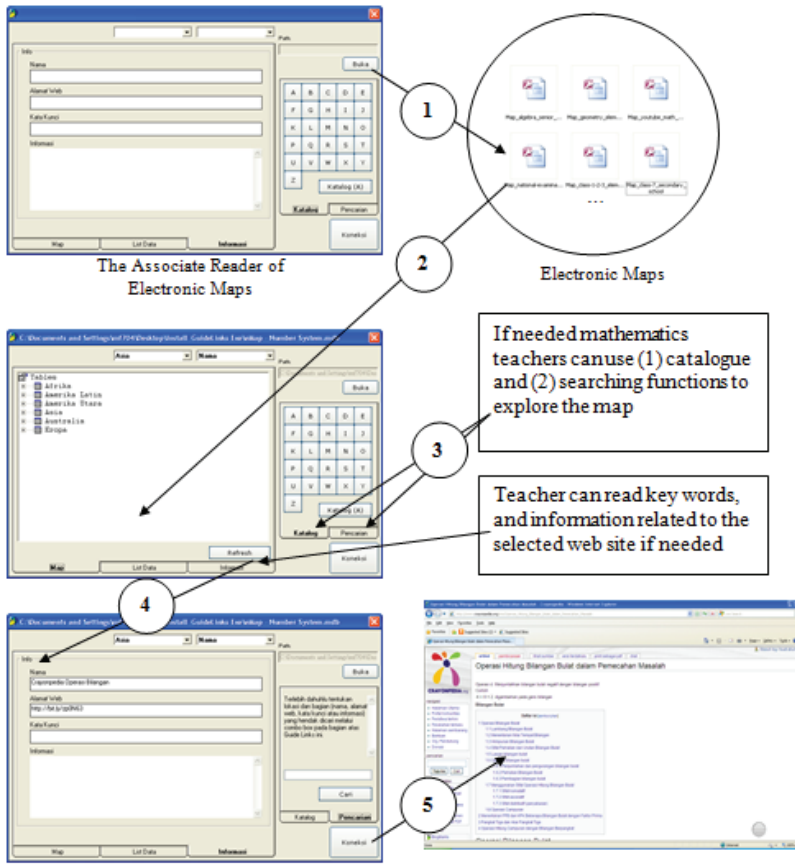


Figure 8. How the Electronic Maps and Its Associate Reader Work.

The proposed visual technique of exploring the Internet without typing a web address or using a search engine may sound strange. However if one looks back into the history of the computer, one will find a "primitive" computer operating systems where people need to type text at the command line. These are still in use today but with modern operating system there is an explosion of the "button" clicking approach rather than text typing.

The collaborative research, including the use of electronic maps by mathematics teachers, was implemented between January and March 2012 with 13 mathematics teachers in Bojonegara Sub District, Indonesia. The details regarding the participants' school level is provided in Table 10.

Table 10
Participant Identity Based on School Level

		Frequency	Percent	Cumulative Percent
Valid	Elementary School	6	46.2	46.2
	Junior High School	4	30.8	76.9
	Senior High School	3	23.1	100.0
	Total	13	100.0	

The numbers of teachers as participating in the interview were not exactly the same as calculated at sample estimation, with less in the senior secondary and more in the elementary school level. The participants are predominantly female as revealed in the cross tabulation of school level and gender in Table 11.

Table 11
Cross Tabulation between Gender of Mathematics Teacher and Their School Level

			Level of School			Total
			Elementary School	Junior High School	Senior High School	
Gender of Math Teacher	Female	Count	5	4	1	10
		% within Gender of Math Teacher	50.0%	40.0%	10.0%	100.0%
	Male	Count	1	0	2	3
		% within Gender of MathTeacher	33.3%	.0%	66.7%	100.0%
Total		Count	6	4	3	13
		% within Gender of Mathematics Teacher	46.2%	30.8%	23.1%	100.0%

The prototype of the electronic maps of mathematics learning resources in the Internet was used by teachers on either a school or home computer. From the total of 13 mathematics teachers participating in the collaborative research, two of them did not use any computer at school, while 11 teachers (76.9%) used computers in the school.

All computers used the Windows operating system. At home teachers used the Notebook (n=8, 61.5%) or Desktop PC (n=5, 38.5%), while at school teachers could use either the school computer or their own as is explained in Table 12.

Table 12

Cross Tabulation between ownership and type of computers in schools

			Computer in School – Type			Total
			Notebook	Desktop PC	Netbook	
Ownership	Owned by School	Count	3	3	0	6
		% within Computer in School – Ownership	50.0%	50.0%	.0%	100.0%
	Owned by Teacher	Count	4	0	1	5
		% within Computer in School – Ownership	80.0%	.0%	20.0%	100.0%
Total		Count	7	3	1	11
		% within Computer in School – Ownership	63.6%	27.3%	9.1%	100.0%

The prototype of Electronic Map of Mathematical Learning Resources in the Internet was used by participants either at school or at home. They initially used it to discover resources, related to education and mathematics in the Internet through electronics maps provided by researcher. The resources visited by mathematics teachers could be mathematical learning resources for references, or for use by them to teach their students. They could also recommend and share the maps with other teachers or their students, so these people could also to visit these resources. Based on their experiences of using the electronic maps, the teachers evaluated this protoype, through a deep discussion with the researcher, and the questionnaire provided. Teachers' satisfaction with regard to the evaluation components of the prototype electronic map as measured on a 5 point scale is reported in Table 13. All teachers reported some level of satisfaction with all components. As displayed in Table 13, the most highly rated components were the idea, function, and innovation of the electronic maps.

Table 13
Teachers' Satisfaction of the Electronic Map

No	Components	Satisfaction					
		Very Satisfied		Satisfied		Somewhat, Slightly, and Not Satisfied	
		Count	%	Count	%	Count	%
1	Idea	11	84.6	2	15.4	0	0.0
2	Function	9	69.2	4	30.8	0	0.0
3	Innovation	9	69.2	4	30.8	0	0.0
4	File Structure	7	53.8	6	46.2	0	0.0
5	Characteristics						
	Database Structure	5	38.5	8	61.5	0	0.0
	Entry Data	5	38.5	8	61.5	0	0.0
	Modifiable and Share ability	6	46.2	7	53.8	0	0.0
6	Implementation	1	7.7	12	92.3	0	0.0

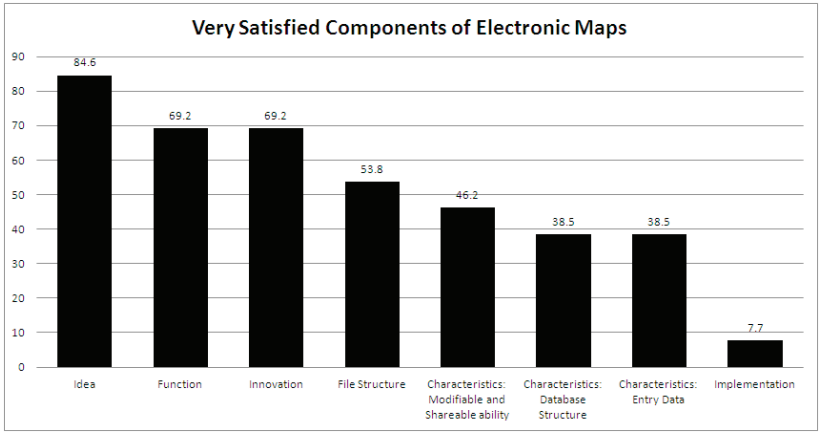


Figure 9. Very Satisfied Components of Electronic Maps (Ordered Highest to Lowest Score).

Table 14

Teachers' Satisfaction of the Associate Reader of Electronic Map

No	Components	Satisfaction					
		Very Satisfied		Satisfied		Somewhat, Slightly, and not Satisfied	
		Count	%	Count	%	Count	%
1	Idea	11	84.6	2	15.4	0	0.0
2	Layout of Software	9	69.2	4	30.8	0	0.0
3	Characteristics						
	Connection to Electronic Maps	8	61.5	5	38.5	0	0.0
	Catalog and Searching Facilities	8	61.5	5	38.5	0	0.0
	One button click to visit selected web site	8	61.5	5	38.5	0	0.0
4	Function	8	61.5	5	38.5	0	0.0
5	Innovation	8	61.5	5	38.5	0	0.0
6	Implementation	2	15.4	10	76.9	1	7.7

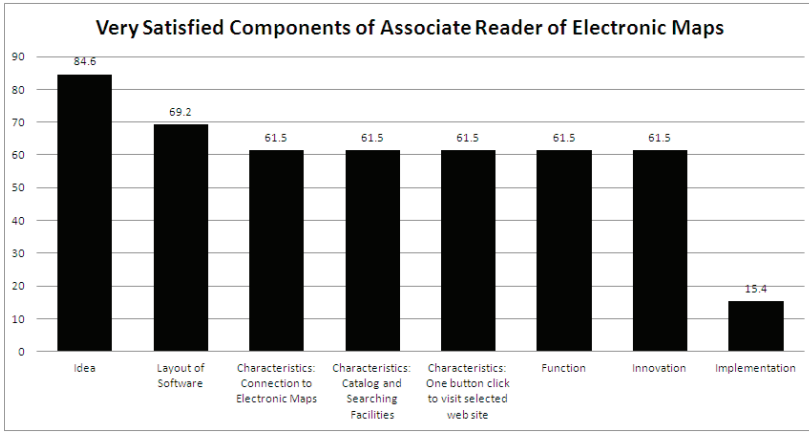


Figure 10. Very Satisfied Components of the Associate Reader of Electronic Maps (Ordered Highest to Lowest).

Satisfaction with the various aspect of the implementation are reported in Table 15, with the perceived benefits the most highly rated (69.2%) but with the ease of use attracting the lowest satisfaction score (15.4%).

Table 15
Teachers' Evaluation Related to the Implementation of Prototype

No	Components	Evaluation					
		Strongly Agree		Agree		Neutral to Strongly Disagree	
		Count	%	Count	%	Count	%
1	Beneficial for						
	Teachers	9	69.2	4	30.8	0	0.0
	Students	9	69.2	4	30.8	0	0.0
	School	9	69.2	4	30.8	0	0.0
	Education office and community	9	69.2	4	30.8	0	0.0
2	Appropriate to current ICT condition	6	46.2	7	53.8	0	0.0
3	Institutionalization						
	Implementation	3	23.1	10	76.9	0	0.0
	Impact	3	23.1	10	76.9	0	0.0
	Self-managed by teachers for a long term	3	23.1	10	76.9	0	0.0
4	Easy to use	2	15.4	11	84.6	0	0.0

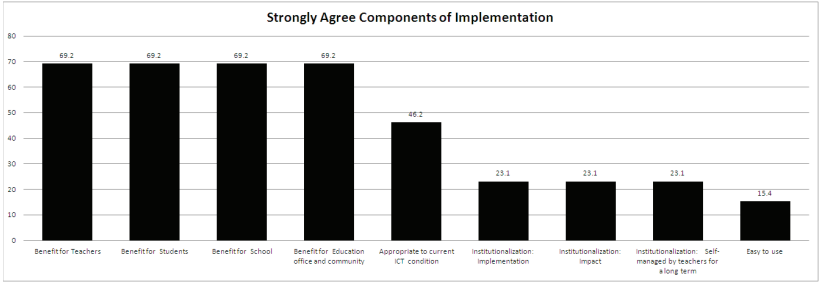


Figure 11. Strongly Agree Components of Implementation (Ordered Highest to Lowest Score).

Discussion

As shown in Figure 12, without electronic maps, each teacher has a different access to mathematical learning resources in the World Wide Web,

dependent on their own knowledge and experiences in accessing resources through the Internet.

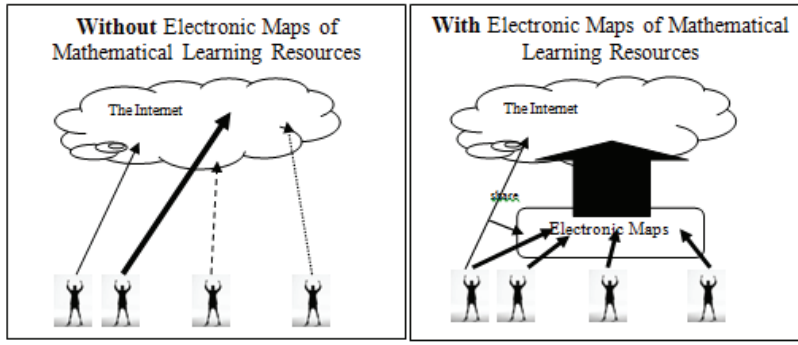


Figure 12. An Illustration of Condition Without and With Electronic Maps.

Electronic maps of mathematical learning resources allow the development of a collective wisdom regarding access to mathematical learning resources in the World Wide Web. They may be supplied at an institutional level showing alignment of resources with the curriculum or the electronic maps facilitate the sharing of one's own knowledge to others. Electronic maps have a dynamic content represented in a geography-based map which is modifiable and shareable among users. This approach is different than an approach provided by for example Kissane (2011), who provides static links through his website.

An alternative conception of the maps is that they can be considered as a guide linking to learning objects in the Internet. Since the map developed by one teacher could be modified, shared and used by other teachers, then these maps are consistent with concept proposed by Cisco Systems in Laverde (2009) regarding Reusable Learning Object (RLO) that can be internally modified or assembled to make new learning objects for different knowledge areas.

According to teachers' satisfaction is greatest for the idea, function, and innovation components of the electronic maps and its associate reader. However more work needs to be done in term of implementation and making the prototype easier to use so that teachers may obtain the perceived benefits.

Given the capability of the teachers in Bojonegara Sub District, Indonesia the implementation of this technology was found to be appropriate. Moreover, the technology was also found suitable given the ICT conditions, specifically computers and internet access in the teachers' schools and

homes. This tool would be categorized as a Web-based Learning Tools according to Kay (2011) description. However, this is a tool for teachers less so students. Since ICT conditions in Bojonegara Sub Disctrict, Indonesia are similar to ICT conditions in other regions of developing countries, this technology would be suitable and useful for teachers in these countries allowing teachers to easily access, download, or use mathematical learning resources for their classes.

CONCLUSIONS

Given the infrastructure available and the capacity of teacher in Bojonegara Sub District, Indonesia, the development of electronic maps was found to be appropriate to the task of providing teachers with better access to mathematics learning resources, and through this to the provision of better education for their students. According to Kay (2011) this tool would be categorized as a Web-based Learning Tools more so for teachers than for students. Since ICT conditions in Bojonegara Sub District are similar to ICT conditions in other regions of developing countries, this technology would be suitable and useful for teachers in these countries allowing teachers to easily access, download, or use mathematical learning resources for their classes.

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