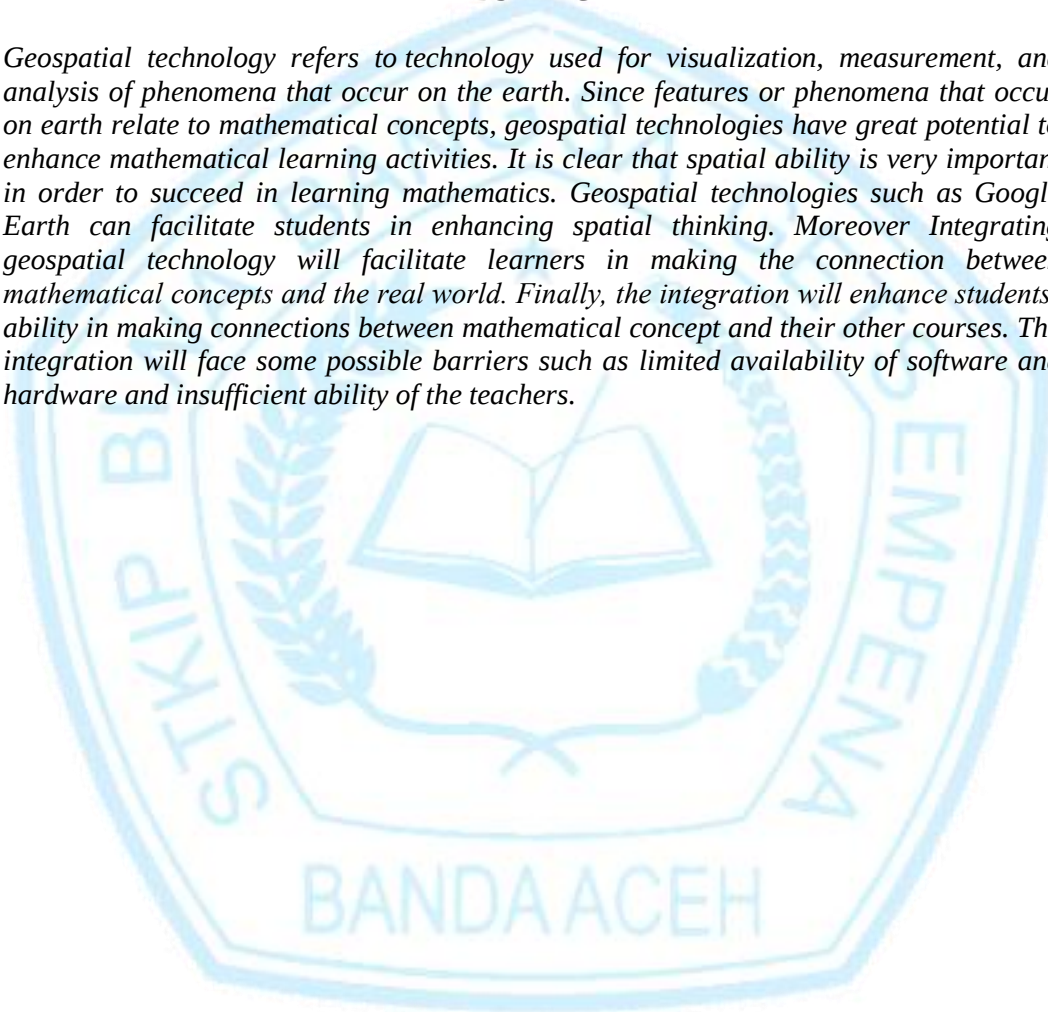


INTEGRATING GEOSPATIAL TECHNOLOGIES IN THE SECONDARY MATHEMATICS CLASSROOM

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ABSTRACT

Geospatial technology refers to technology used for visualization, measurement, and analysis of phenomena that occur on the earth. Since features or phenomena that occur on earth relate to mathematical concepts, geospatial technologies have great potential to enhance mathematical learning activities. It is clear that spatial ability is very important in order to succeed in learning mathematics. Geospatial technologies such as Google Earth can facilitate students in enhancing spatial thinking. Moreover Integrating geospatial technology will facilitate learners in making the connection between mathematical concepts and the real world. Finally, the integration will enhance students' ability in making connections between mathematical concept and their other courses. The integration will face some possible barriers such as limited availability of software and hardware and insufficient ability of the teachers.



A. INTRODUCTION

Information is rapidly increasing in this digital era. It is difficult to teach all this new information to students. Even if this could be achieved, new information is added every day. It is important to teach students how to find information and how to use it in problem solving instead of simply teaching the information itself. Students should be able to make decisions by analyzing new information instead of memorizing the existing information. There are many technologies that allow users to access and analyze information. The geospatial technology is one of the technologies that enable users to collect and analyze information.

The geospatial technology refers to technology used for visualization, measurement, and analysis of phenomena that occur on the earth. The geospatial technology relates to mapping features on the surface of the earth, the technology systems such as GPS (global positioning systems), GIS (geographical

information systems), and RS (remote sensing). Since features or phenomena that occur on earth relate to mathematical concepts, geospatial technologies have great potential to enhance mathematical learning activities. This paper discusses about why geospatial technologies should be integrated in the secondary mathematics classroom, how to implement the technology, and the possible barriers to the integration.

Why the geospatial technology should be integrated into the secondary mathematics classroom

There are many reasons why the geospatial technology should be integrated in the mathematics classroom. Most of the reasons are related to curriculum reform in school mathematics. The following are reasons for integrating geospatial technologies in the mathematics classroom.

To implement principles and standards of school mathematics

Mathematics standards for the mathematics classroom described in the National Council of Teachers of Mathematics (NTCM)'s principles and standards requires a high level of mathematical skills. Proficiency in calculations, equations, and basic geometry are no longer considered as enough for a mathematically literate person. Instead, mathematical fluency now includes skills in areas such as representations, communication, and connections to other disciplines (NTCN, 2000).

Integrating technology is one of the important ways to enhance mathematical fluency. Geospatial technologies are tools which can be integrated in the mathematics classroom to achieve mathematical fluency. By integrating GIS, for instance, in the mathematics classroom it will facilitate the class to meet higher academic challenges as the class engages in investigations of real world problems. The investigation is to promote the comprehensive understanding of mathematics.

Geospatial technologies have features to support implementations of the mathematics standards. The following are samples of NTCM's standards supported by integrating geospatial technology:

- Data analysis and probability: “the student should be able to formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them.” This standard can be achieved by integrating GIS in the classroom.
- Geometry: “The student will solve practical problems involving right triangles.” GPS has features to facilitate learning in order to achieve this standard.
- Geometry: “The student will use formulas for surface area and volume of three-dimensional objects to solve practical problems.” Google Earth has 3D mode features that can help to facilitate students learning this geometry standard.

To foster problem solving skills

Enhancing problem solving skills is one of the objectives of learning mathematics. Geospatial technologies can be used in the classroom in order to promote problem-solving skills, such as using GIS in the classroom. The use of GIS in the mathematics classroom fosters problem solving skills through various activities such as acquiring data to investigate, observing and analyzing patterns in that data, and drawing inferences and conclusions from data analysis.

To enhance spatial ability

Spatial abilities have been considered to be a very important aspect in succeeding in learning mathematics and particularly geometry. The importance of spatial abilities to the development of mathematical thinking is supported by many researchers (Presmeg, 2006). Hegarty and Waller (2004) supported that spatial abilities are important for both constructing and comprehending abstract spatial representations in mathematical problem

solving. In addition, learning mathematics requires abilities associated with visual perception and spatial.

It is clear that spatial ability is very important in order to succeed in learning mathematics. Geospatial technologies such as Google Earth can facilitate students in enhancing spatial thinking. In addition, the technology can also be used as a tool to help students in learning topics related to spaces.

To promote logical-mathematical intelligence

Integrating geospatial technology in mathematics classroom can promote logical and mathematical intelligence, for instance by integrating GIS. According to Environmental System Research institute in its document "Exploring Common Ground: The Educational Promise of GIS" (2006), among other advantages of integrating GIS in the classroom is to engage and excise multiple capacities and intelligences in critical thinking, logical-mathematical intelligence, linguistic intelligence, spatial

intelligence, and interpersonal intelligence of students.

To make connections between mathematic and the real world

The national Council of Teachers of Mathematics (2000) suggested that teaching mathematics should emphasis on solving ‘real world’ problems and making connections between mathematical concepts and the real world. To achieve such goals, geospatial technologies such as Google Earth and GPS can play a very important role. Besides using this technology as a tool to make a connection between mathematical concepts and the real world, GPS also has a very high potential to be used in learning activities that keep students in contact with real world activities. This is very important in order to avoid the negative effect of integrating technology in the classroom, which can remove students from contact with the real world (Broda & Baxter, 2003)

To make connection between mathematics and other content areas

The National Council of Teacher of Mathematics (2000) also suggested making connections between mathematics and other content areas and exploring interrelationships among the concepts. Making connections between mathematics and other subjects has become an important issue for some associations such as School Science and Mathematics Association (SSMA) and NTCM. They support the integrating of math and science, which is reflected in their national standard documents, such as the NTCM standards. Geospatial technology such as GIS, according to Furner (2000), is an excellent program interlinking mathematics and science.

How Geospatial technologies be integrated in the secondary mathematics classroom

Google earth in the mathematics classroom

One of the most commonly used geospatial technologies in mathematics classroom is Google Earth. This free

software has quickly become popular. Its popularity has led to Google Earth being more easily integrated in the classroom than other geospatial technologies. The strength of Google Earth is in its ability to clearly display and explore data while not requiring the user to have advanced skills.

Examples of mathematics learning activities which utilizing Google earth

- The teacher can use Google Earth while teaching concepts of polygons. Students and the teacher can look at *The Pentagon* through Google Earth during a learning activity. By using dynamic mathematical software such as *GeoGebra* or *Autograph*, the teacher and students can embed the picture of The Pentagon into the software and the students can learn about the concepts of pentagons such as interior angles.
- The teacher can use Google Earth with 3D mode while

teaching the concept of pyramids. The teacher and students can look at The Great Pyramid at Giza in Egypt through Google Earth, then they embed the picture into dynamic mathematics software to learn the concept of pyramids.

- While learning the concept of a parabolic curve, the teacher and students can “travel” around the world through Google Earth to find the earth’s features that look like a parabolic curve. Then they can embed pictures of the earth’s features on the dynamic mathematics software to learn the values of a parabola from the features.

There are many other topics that can be taught by integrating Google Earth, such as measurements, volume of solids, line graphs, polyhedrons, distances, spherical geometry, etc.

GPS in the mathematics classroom

Integrating GPS in the mathematics classroom offers a good opportunity to make a connection between mathematical concepts and the real world. GPS can be integrated in learning geometric baselines and algebraic equations. By integrating GPS, students learn how to calculate time and distance using satellite data. Students learn put to use numerical data into a surface expression. At the same time, students learn about the topography of the area in which they are collecting data and determine the location of the particular designated points of longitude and latitude.

Examples of mathematic learning activities which using GPS

The teacher can use GPS in teaching finding the areas of geometrical figures such as right triangle and rectangles. Students can do the following:

- First, students find the latitude and longitude for some places on the school campus, such as the dining hall, basketball field, library, etc.

- Second, students plot the points of the place on a map.
- Third, students draw lines to connect the points.
- Some connections will probably form some geometrical figures such as triangles, right triangles, parallelograms, rectangles, etc.
- Finally, students calculate the area of the geometrical figures

GIS in the mathematics classroom

Several aspects of mathematics can be promoted by integrating GIS in the classroom. There are some standards for mathematics in the secondary classroom that have the potential to have a significant effect by integrating GIS, such as a data analysis standard.

Example of mathematics learning activities used GIS

- Students use GIS to analyze the census data while they are learning algebra. Students investigate and describe changes in the data. This investigation leads student to learn algebra concepts such as the slope of a

line.

- Students work with coordinate geometry in locating places on their maps. This activity will lead students to develop their geometry skills.
- Students make generalizations and find a pattern of the data. This will develop their reasoning and proofing skills.

The potential barriers of integrating geospatial technologies in the secondary mathematics classroom

In order to achieve the positive results of integrating the geospatial technology in the mathematics classroom, teachers need to be sufficiently knowledgeable about learning and teaching mathematics with technology. This implies that mathematics teachers need to be consistently implementing the technology in the classroom. In order to be consistently implemented, the availability the tools and adequate knowledge about using the tools is critical. Some of geospatial technologies

are commercial tools, such as GIS and GPS, so that limited access to hardware and software will be one of barriers. Another barrier is that the time required for teachers to learn geospatial software such as GIS software. Moreover, the last barrier is that it takes time to prepare materials for learning activities.

B. CONCLUSION

In conclusion, integrating the geospatial technology in the secondary mathematics classroom can have many positive results. It influences not only the way students learn but also leads to meaningful learning activities. Integrating geospatial technology will facilitate learners in making the connection between mathematical concepts and the real world. Moreover, the integration will enhance students' ability in making connections between mathematical concept and their other courses. This integration will face some possible barriers such as limited availability of software and hardware and insufficient ability of the teachers.

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