LEARNING MATHEMATICS IN A VIRTUAL WORLD: INVESTIGATING WITH MS WORD

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Abstract

Learning Mathematics in a virtual world is an opportunity that is demanding and challenging. Various processes have been employed in classroom instruction through different educational packages to enhance particular mathematical concepts. In Botswana, various mathematics educational packages such as MS Word and MS Excel have been used in professional development for secondary school mathematics teachers. The aim was to present a new strategy for Botswana school mathematics teachers' in-service training about integrating ICT into mathematics teaching and learning. Instead of classroom oriented instruction and practices, we emphasized the needs of real world practices where mathematics may also find new territory as new tools are used, new application areas are involved, and new approaches of using mathematics are employed. In this paper we report our focus on mathematical investigations using MS Word drawing tools in teaching geometric constructions at secondary school level. A new training model of three phases is presented whereby in phase one teachers start mathematics investigation of drawing tools to find out how tools are designed, different approaches for the drawing task are used, and the study of features of various methods. In phase two, teachers discover the procedures of using MS Word drawing tools imitating the ways we do mathematical construction in classroom. Possible conversions, modifications, associations are discussed. The last phase suggests the designs of learning activities for mathematics teachers.

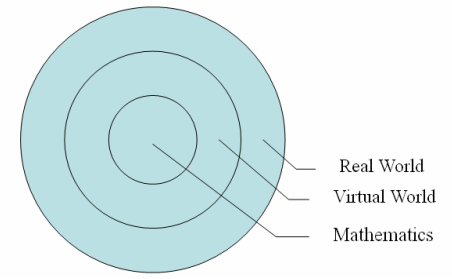
Introduction

Traditionally, mathematics has been taught using textbook examples and exercises in the real world, to model and analyse mathematically. Students had to develop an understanding based on textual descriptions and 2D representations. Computers have provided a platform for instructions where complex actions and ideas can be easily represented and interpreted. The advent of computers has allowed students to manipulate the parameters of a simulated experiment and record results in the virtual world. Technology enhances mathematics learning by furnishing visual images of mathematical ideas, facilitating the organization and analysis of data, as well as computing efficiently and accurately (Kaino, 2008). The technological tools enable students to construct visual and symbolic representations of ideas and incorporate these into their approaches and thinking about problems. The technology-enabled visualizations facilitate students' mental images, which help them to form, relate, and organize mathematical concepts. Virtual world platforms provide support for imitation-based instructions, learning styles, assessment and evaluation, and teachers' professional development. Through visual reality, students can explore and manipulate abstract mathematics concepts and the mathematics problems in the real word.

Learning Mathematics in a Virtual World

Learning Mathematics in a virtual world is an opportunity that is demanding and challenging.

In this paper, real world (also "real life") is a phrase used to refer to the physical reality of everyday life. A virtual world is a computer-based simulated environment. The relationship between the mathematics activities in the real world, the virtual world and in the classroom can be illustrated in a diagram:



The world is changing in such way that more and more human activities will take place in a virtual format. Simulation of a real world situation in a virtual world will become more essential as a step of problem solving.

The virtual world is basically built on a mathematical foundation. That is why the virtual world sometimes can be called the digital world. Quantities such as size of memory and resolution are noted and calculated. The use of color system is another example that in virtual world every quantity including a color should have its digital definition. A percentage value has been used to determine the change of objects' sizes, color transparency, the control of zoom scales etc. Different units are used and can be converted from one to the other.

The virtual world was initially built as a tool to solve the problems encountered in the real world. Therefore our impression of learning in the virtual world could be all about getting instructions of how to use tools. Actuarially, as the user of certain application software, we should not passively follow the instructions only for operating a procedure. There is a need to discover a suitable way of using tools designed. Most tools will most likely be modified in different occasions. In this regards, we may treat the virtual world as a part of the real world, where a comprehensive investigation could be conducted for creative use of tools.

Computers and the Mathematics Classroom

The success of computer integration in classrooms depends on the competence of teachers to use this technology. The inability of teachers to fully use computers is a major obstacle towards computer-assisted teaching in the classroom. Training teachers on the use of computers is a pre-requisite towards incorporating computers in teaching especially mathematics. A needs' assessment exercise by the Department of Mathematics and Science Education INSET unit, revealed that teachers did not use computers largely due to concepts that could be taught without using computers. However, studies have shown that the limited quantity, lack of teacher in-service training and under-utilisation of computers by teachers impede the effective use of computers in the mathematics classroom (Bright, 1994; Bitter & Hartfield, 1994; Mooketsi, 2000; Kyeleve, 2000, Letlotlo, Kyeleve & Liu, 2002). The researchers believe in the need to encourage the use of general application software that was available to all schools. Excellent application software like MS Word is easily accessible in Botswana schools. Since MS Word was the frequently used software, it was significant that for the training of teachers, the researchers chose MS Word drawing tool to create connections between real world and classroom mathematics teaching and learning. It needs to be noted that the drawing tools in MS Word are not the same as tools used for drawing in our

classroom. It is possible to modify these tools in order to perform the same constructions in the same manner as we do in the classroom environment. In this paper we report our focus on mathematical investigations using MS Word drawing tools in teaching geometric constructions at secondary school level.

Microsoft Word Drawing Tools

MS Word drawing tools are designed as an accessorial part in word processing. For example, we could think about inserting graphic illustrations into a book when we may use the drawing tools temporarily to make drawings which are among the texts. School teachers use MS Word to type up an examination paper, or a handout for in-class mathematics activity, etc. It is necessary for mathematics teachers to know how to use the drawing tools provided in MS Word, to create high quality drawings in the production of teaching materials.

Comparing MS Word drawing tools to other graphic editors, there are some similarities and differences. Many benefits of MS Word drawing tools are similar to those in other graphic editors. For example, drawing with grids, snapping to grids or objects, layers, orders, zooming, transformations of objects, units for measuring, etc are widely used. Using drawing tools in MS Word will help teachers and students to know other graphic editors, such as Flash, Photoshop, CorelDRAW, SketchUp, 3D Max, AutoCAD, etc. A line in Euclidean geometry has only length, but in MS Word a line has length and weight which is the width of the line. A shape in MS Word has a border with various values of weight. Every function is designed to achieve a certain objective. On the other hand, there are many unexpected results are produced when more than one function is integrated. Sometimes we could regard MS Word, or the virtual world in large as a part of the real world where we can discover many new methods and new syntheses of using MS Word drawing tools.

MS Word drawing tools are not for mathematics constructions. Although there are grids and coordinates for positioning purposes (user normally cannot control the positions by entering values for the coordinates), the tools do not use coordinate systems for drawing. Drawing with MS Word is more or less like constructing with straightedge and compasses. That is why we regard MS Word as an environment in the virtual world, as opposed to being a mathematics tool. Drawing tools in MS Word serve as groundwork for teachers and students to know other geometric tools, such as Geometers' SketchPad, etc. Other kinds of application software, such as Google SketchUp can be regarded as a 3D virtual environment, where many mathematics activities can take place. It is important for mathematics teachers to convert MS Word drawing tools into geometric construction where possible. Transformations are used in MS Word, but they are different from those taught in secondary school mathematics. Drawing in MS Word is not in pursuit of "one-click automation", getting result directly. Therefore detailed construction process can be shown to the learners; however it may not be seen as a powerful tool for construction.

Reality

In Botswana, all the government secondary schools are equipped with at least one computer laboratory. Microsoft Office is available on all computers not only because computer-related subjects cover contents such as word processing, spreadsheet and database in their syllabi, but also for teachers to use it in their school work. As a developing country, Botswana can benefit from the virtual world. Nevertheless, it is not practical for Botswana to develop sophisticated application software, while the cost to obtain and renew the licence of using specific application software is very high. The use of freeware and redevelop educational functions of

most available application software could be unproblematic.

If we merely list common reasons of why we use computers, we may find that it is to reduce the work load (automation), to create better presentation, to add some efficiency or effects to our teaching, to find new areas where mathematics knowledge will be applied, to develop students' skills to handle the real problem with mathematics, and many more. We find that some common application software, like MS Word could achieve all the intentions to a certain extent.

The problem of our in-service training in ICT does not only base on our ability to provide teachers with the most advanced technology. It is more about how to amend teachers' altitude towards ICT. There are some misunderstandings of ICT. Is the computer a machine that we just need to operate? To what extent do we rely on the step-by-step instructions? Are workshops the only way to learn new application software?

The reality is that mathematics exists in the virtual world in which more mathematics activities will take place. We are not in the position to claim that ICT is only an alternative for us to decide if we should use it or not. It does not matter if one or another sort of application software is available. Mathematics teaching should react to and involve the virtual world. We should carry out investigations not only in our teaching but also in the process of integrating ICT. In other words, we could say that our mathematics investigation should take place in our in-service training of ICT, and our training is mathematics processing taking place in the virtual world.

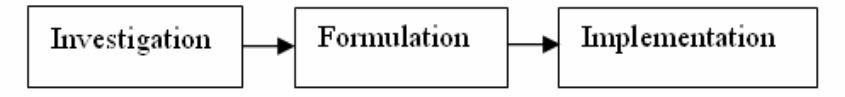
Strategies

The strategies for Botswana school mathematics teachers' in-service training on integrating ICT into mathematics teaching and learning aim to:

- Find the real situation on teachers' use of computer in Botswana. Find out their needs and aim at solving their problems.
- Open teachers' minds to accept the virtual world in a natural manner instead of sticking like a limpet regarding the ways to use fewer advanced mathematics tools. Start using computers promptly with whatever application software is available, rather than waiting for some more sophisticated application software plus comprehensive tutorials to approach.
- Discover mathematics used in the virtual world. Discover the tools in the virtual world which can be useful for any mathematics activity. Mathematics may find new territory as new tools are used, new application areas are involved, and new approaches of using mathematics are employed.
- One of the tasks we emphasized is how to represent a real world problem in a computer-based environment.
- Trainee-centred training: Training encourages teachers to discover, explore the uses of drawing tools, formulate the procedures of using tools by themselves, and use them in their teaching context. Training aims at developing teachers' confidence of integrating ICT into the classroom.

The Training Model

The objective of the training on investigating the use of MS Word Drawing Tools in geometric constructions among others, is to enable mathematics teachers to experience and enhance school mathematics using various technology tools for discovering and exploring real world applications, engaging in problem solving and problem formulation, and communicating the results of mathematics investigations. Therefore a suggested three-phase training model was used.



In phase one, teachers start mathematics investigation of drawing tools to find out how tools are designed, how different approaches for drawing task are used, and the study of features of various methods. In phase two, teachers discover the procedures of using MS Word drawing tools, simulating the ways that mathematical construction are done in our classrooms. Possible conversions, modifications, associations are discussed. In the last phase, learning activity designed by mathematics teachers is suggested.

Phase one: Investigating the drawing tools

Teachers will be given the tasks instead of instructions to explore MS Word drawing tools and other facilities. Different drawing tools such as line, arc, rectangle, circle, isosceles triangle, right triangle, etc, have been tested. Some other functions such as property window, viewing size, grids, snapping, grouping, nudge, order, alignment and distribute are also tested. For each tool, there are different methods of using it. Teachers are encouraged to compare them and record the behaviours of various methods.

Experiment 1 Learn about the sizing handles: It is found that left and right side-handles are used to stretch the object horizontally, and top and bottom side-handles are for the vertical sketching. The corner-handles are for both horizontal and vertical stretches. Using SHIFT + corner-handle will change the size only but no change for the shape, i.e. both stretches have the same factor. Using CTRL + corner-handle will change the shape at the centre of the object. Using SHIFT + CTRL + corner-handle will perform an enlargement at the centre of the object.

Experiment 2 Investigation with macro: A macro involving the use of drawing tools can be investigated in VBA. The procedure is as follows: Record one or more action as a macro, read it in Visual Basic Editor, and understand how it works. Our intention is not to learn programming language VBA. But we believe that relate the VBA commander in a macro to the behavior or result about a drawing tool will help teachers to understand why and how the drawing tool perform a function.

Phase two: Formulating the procedure of using a tool

Discover the procedures of using MS Word drawing tools imitate the ways we construct in classroom. Possible conversions, modifications and associations have been discussed. It is our ambition to imitate constructing with normal mathematics instruments, such as ruler, compasses, set square or protractor in the MS Word environment. It becomes important to develop a series of steps to achieve a certain task in a way that can be understood by our students.

Procedure 1 How to use the arc tool to imitate the compasses? Of course there is no compass tool in MS Word, but if we follow the procedure: *Get the default arc; Position the centre; Adjust the radius; Change the range of the arc*, then the arc tool could imitate all functions of a compass.

Procedure 2 How to find the centre of a circle? The oval tool can be used to make a circle without showing the centre. Here is a procedure of finding the centre: *Make a circle; Duplicate it in the same position; Using SHIFT + CTRL + corner handle to reduce the second circle to a "point"; Group both*. This method is completely different form that of finding the centre of a circle with compass and straightedge only.

Other procedures: Measure the length of a line segment; Measure the angle by rotating a line; Find the mid-point of a line segment; Construct angle bisector.

Phase three: Learning activity design

Learning activity designing is for mathematics teachers to undertake mathematics problem solving tasks. Mathematics may also find new territory as new tools are used, new application areas are involved, and new approaches of using mathematics are employed; of course, some new topics will be explored. The followings are some activities we designed during the workshop.

Activity 1 Use of virtual protractor: Apart from the tools provided in MS Word, we even create a virtual protractor used on screen by scanning a real protractor, making the background transparent, and moving or rotating it on the screen to measure the angle.

Activity 2 Create your personal drawing tools bar: It is very important for mathematics teachers to create a personal construction tools bar. It usually involves two tasks: Select and rearrange the existing buttons; Create buttons for new tools. The following is an example. It consists of transformations buttons, some new tools like point, circle with centre, line with mid-point, and other most used buttons which normally need two or three steps to open. Macros are used in making new tools. InputBox is used in the macro to get values calling for different functionalities.

Activity 3 Design a Botswana traditional basket: Botswana traditional basket with many other local handcrafts has various geometric patterns. By taking photos and insert them into MS Word, we are able to analyze them in a mathematics manner. Design a new pattern in MS Word will involve transformations and many other geometrical operations.

Other activities: Demonstrate transformations; Using subsidiary shapes (AutoShapes) in Logo design; Create a continuous rotational symmetric figure; Using macro in rotational symmetric figures; Fractals; Tessellations.

Conclusion

Teaching and learning mathematics in a virtual world could be a better description of integrating ICT into mathematics teaching than introducing advanced mathematics software into schools. It is especially appropriate for schools in developing countries. Since we are

living in a computer-based environment, we are not only choosing one or two mathematics tools to use. Instead whatever application software where mathematics is applied, and mathematics problem can be solved, should not be rejected. In this regard, there should be no bias on what application software to use in mathematics teaching while MS Word drawing tools could be developed for school mathematics teaching and learning. There are two tasks for this purpose: one is how to transfer a real world problem to a problem in the virtual world; and the other is how to modify the tools that exist in the virtual world to solve mathematics problem. Using MS Word drawing tools will definitely give us the opportunity to achieve those two tasks. There is a direct channel for teachers to access the virtual world, which is the mathematics investigation based on our mathematics knowledge. There are also many new topics and new problems that can be explored in the virtual world. We are not seeking for one-click automation in the use of ICT, but searching for a presentation of mathematics process with meaningful details. We are not in favor of specific mathematics or educational application software, but the exhibition of the integration and flexibility of using different application software in mathematics problem solving.

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