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ICT IN MATH EDUCATION – SMALL INTERACTIVITIES & SPECIFIC GOALS

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ABSTRACT

In this paper we discuss the integration of ICT into mathematics education. We look at the real concerns of educators and discuss why this process so often fails – that is, why technology has not improved the knowledge, skills and logical thinking processes of our young people that are the goal of math education. We consider the essential conditions a technology application must fulfil in order to be successfully integrated into the educational system. We illustrate this process with a concrete example of a complete ICT activity that shows a well planned, well-documented activity with small ICT interactivities with precise, narrow goals that can be easily integrated into existing curriculum here in Macedonia and elsewhere and give the desired result.

Keywords: ICT, education, mathematics, interactivities, integrating technology

1. Introduction

We look at the integration of ICT into mathematics education. The current reality is limited – not just here in Macedonia, but globally. Teachers and school administrators have not seen the results promised by educational and ICT professionals. Sadly, they have been disappointed again and again by what seems to be a lot of time, effort and money for no real results.

We look at their concerns and discuss why this integration so often fails. We consider whether it is indeed possible that integrated technology can help train our young persons with the skills and logical thinking processes that are the goal of math education. We take into consideration the perspective of education here in Macedonia where integrating ICT is additionally restricted by both cost and language.

We set forth a series of conditions that must be met before developing any applet/application. We give particular emphasis to the design of small interactivities with precise, narrow goals that can easily be integrated into existing curriculum. Finally we give a sample ICT activity which we think satisfies the conditions for successful integration of ICT into mathematics education

2. ICT in Education – Is it working?

Both teachers and pupils/students have found the integration of ICT in education is often ineffective, time-consuming, expensive and inefficient.

One of the main reasons for this failure is that the integration is "top-down". "Experts" are doing the research, design and development. Who are these experts in general? They are university professors, educational professionals, ICT experts and corporations. Teachers – real classroom teachers – are rarely consulted until the implementation phase. But when an application designed by the "experts" does not show the expected results – it is the teachers who are blamed.

Technology looking for an application or vice-versa?

What kinds of ICT integration are most frequently produced by the "experts"? We like the phrase "technology looking for an application". The technology is developed and then the presentation – interface is considered. Large money is poured into the development of large "wonder" applications which will supposedly revolutionize the classroom.

The problem is that these applications do not consider the daily lives of teachers and students. These programs don't get used in a way that improves learning simply because they don't fit the curriculum needs of anybody, anywhere.

No matter where you live, the life of a teacher is similar. They have a curriculum plan with goals, a curriculum program with the content-of-the-day or -week and an assessment process. It is their job to ensure that their students successfully complete this system. Any integration of technology must fit easily into this system and contribute to the success of the system or it will not be used. Period. The application must precede the technology not vice-versa.

3. Successful Integration of ICT in Education

There are many studies and papers concerning the conditions for successfully integrating ICT into education.

There is an old saying: What are the three most important factors to starting a successful business? The answer is "location, location, location".

What are the three most essential components for the successful integration of technology into the classroom?

Answer: "teacher, teacher, teacher"

Specifically: Teacher **can** use it. Teacher **will** use it. Teacher **wants to** use it again.

- Teacher can use it.
  He/she can find it, understands how to use it and feels comfortable using the applet/application.
- Teacher will use it.
  He/she can integrate the applet/application relatively effortlessly into daily curriculum. That is, it fits into existing lesson plans and requires little or no extra setup.
- Teacher wants to use it again.
  He/she sees measurable results from using the applet/application. That is, students are more engaged in the learning process and/or test results improve.

Further, essential conditions 4-6 are student, student, student.

- Student can use it.
  He/she is personally engaged by the applet/application.
- Student will use it.
  He/she has ready access to it in his own time framework.
- Student will use it again.
  Or rather, he will show his friends and pass it on.

Can use it

The applet/application must be straightforward to use and understandable. The teacher must be able to adapt it to his style of teaching. Both teacher and student must be sufficiently engaged to explore different possibilities. If the student is only "pressing the buttons", this is just the ICT equivalent of copying his friend's homework.

On the other hand, engaging does not mean entertaining. It does not have to be a game. It doesn't need "whistles and bells" (or the screeching of dying vampires). But, both teachers and students like applications that encourage teamwork and provide some type of instant feedback.

Will use it

If it is expensive commercial software, then the student is limited to either passive viewing while the teacher uses it or using it only in the computer laboratory. Neither is acceptable. It won't give measurable results. Learning requires personal interaction on the user's terms.

However, no one – not even the US – let alone R. Macedonia can afford to pay commercial licensing fees for a typical student load of 7-10 subjects yearly, with upgrades.

So education must support the development of quality open-source, translatable freeware and encourage educators to try, comment on and contribute to a network of free resources.

Wants to use it again

If an ICT activity helps the teacher explain or helps student understand and/or succeed on the test, the activity will be reused. If it doesn't do these things – the application is dead.

So what are some of the basic components of a good applet/ application – particularly one to be used for mathematics?

4. Successful Integration of ICT in Maths Education

We have seen that for the successful integration of ICT into the educational process, the most important factors are the attitudes of the teacher and the student. Now we turn our attention to specific factors to consider when designing an applet that will help us realize our goal of enhanced learning.

Of primary importance is that the applet/ application must be part of an activity and we must be very specific about the relationship between the activity and the curriculum. We call this key design factor a ***curriculum relationship.***

Curriculum Relationship

In mathematics, we work with three types of learning, namely factual learning, maths skills and logical thinking processes.

So - as is usual – first we must determine the specific goals of the **activity** with respect to these three learning processes.

After doing this, we can then ask how to best use ICT to enhance the learning in the activity.

What kind of interactivities should the applets provide?

- What are the facts one needs to know to use and what facts will be learned from the applet?
- What are the skills one needs to know to use and what skills will be learned from the applet?
- What types of logical thinking process are required? What thinking processes will be learned?

The curriculum exists. The activity must contribute to the curriculum and the ICT applet/application must contribute to the activity. This is a curriculum relationship.

Activity Linked to Standards

Most countries now have standards for mathematics. This is extremely helpful in developing activities with a curriculum relationship. Standards state the capabilities that a student should acquire. For example, typical math standards for 6th or 7th grade geometry include:

> (1) Use several angle properties (properties of complementary and supplementary angles and the sum of the angles of a triangle to find an unknown angle measure. (2) Use properties of isosceles triangles.

So an activity that explores these capabilities would likely fit into most curricula. Linking activities to standards – even if they are not the specific standards of the country - makes it straightforward for a teacher to search for, find and determine whether an ICT activity will fit into her curriculum.

Putting it all together

Finally, when designing and documenting an ICT activity, we must be very specific about the ICT requirements of the applet/application. Of course, this includes hardware and software requirements, but it also includes documenting and testing the ICT literacy skills needed to install and use the applet with real teachers and students on "regular" computers.

In figure 1, we show the interdependence of the three components we discussed. Effective ICT integration into education needs all three components to work together – the ICT literacy requirements of the activity, the curriculum relationship of the activity and the ICT activity/applet itself.

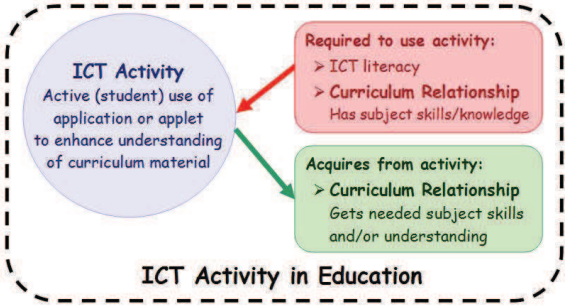

Figure 1: Requirements/Acquirements of ICT Activity

These requirements and acquirements must be considered and all of the above questions answered ***before*** designing the ICT activity. Anything else is just "technology looking for an application".

5. Sample ICT Activity

Keeping in mind all of the above, we discuss a sample ICT activity that we developed. The activity is freely available online and contains printable materials, downloads for offline use and the entire activity for direct online use. This allows the teacher a wide range of options.

Printable Materials

The printable materials consist of two pages. A one-page handout for student and a separate page with metadata and complete instructions for the teacher (see fig.2). Printing materials costs money so it is important to keep the number of pages to a minimum. However, even if there is space on the monitor, it is very difficult to do an activity and read the directions on the computer so something printed is essential.

The student handout states the mathematics under discussion, directions for using the ICT interactivities and questions that the student must answer as he does the interactivities.

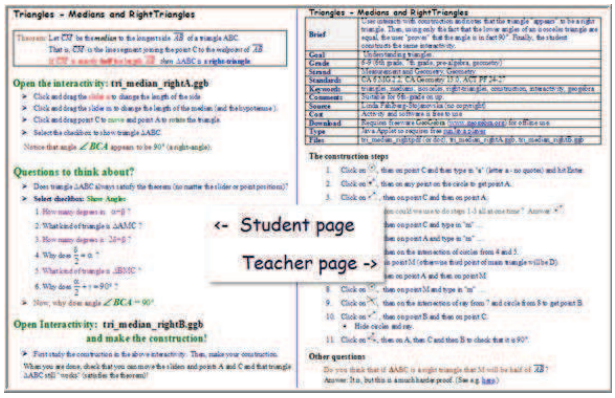

Figure 2: Printable materials for activity

A teacher's guide is important too. No teacher wants to look like a fool and not know the answers, but on the other hand, they simply do not have time to work out best solutions. That time is better spent thinking about how to use the directions in a way that complements their classroom needs and style.

Also, we think it is a good idea to provide the materials in pdf format for easy and safe printing *and* in doc (Word) format so that a teacher can make changes if he/she wants.

Metadata

The metadata on the teacher page and again on the webpage itself is essential. This data answers the questions concerning the ICT, the ICT literacy requirements and the curriculum relationship of the activity.

Here in this activity, the metadata on the ICT states that all programs required are freeware without copyright.

To establish the curriculum relationship,

- Keywords are given (search engines find the activity).
- Grade level and strand are given.
  Here: 6th-7th grade, pre-algebra, geometry
- Corresponding mathematics standards for the activity are stated and links to these standards are given.
  Here: the standards are those given in part 4 above.
- A brief summary of the activity is given.
  Here: User interacts with construction and notes that the triangle constructed under the given conditions "appears" to be a right triangle. He then uses standard 6th grade geometric facts to prove that the angle is in fact 90°. In a second interactivity the user constructs the triangle.
- Pre-knowledge requirements are stated.
  Here: Students must know: the sum of the three angles of a triangle is 180°, supplementary angles add to 180° and the base angles of an isosceles triangle are equal.

The Interactivities of the Activity

Typical for these types of activities are 2 ICT interactivities. In the first interactivity, the student explores and experiments to get an understanding of the concepts under discussion. In the second interactivity, the student constructs – that is, actively demonstrates his understanding.

We invite you to try the activity in English at:
http://mathcasts.org/ mtwiki/Activity/TriangleMedianRightAngle
or in Macedonian at:
http://www.emathforall.com/wiki/Aktivnosti/TriagolnikMedijanaPravAgol
Please send us your comments and suggestions.

6. Summary

The essential components of successful ICT integration into education is that both teachers and students (a) can use it, (b) want to use it and (c) want to use it again, that is succeed from using the application. To satisfy these conditions, we focus on the idea that any ICT interactivity or applets must form an integral part of an activity and the activity must contribute directly to and integrate easily into the existing curriculum. This forms a "curriculum relationship".

In mathematics, a curriculum relationship means designing small ICT interactivities with precise, narrow goals and with specifically stated requirements and acquirements of facts, skills and logical thinking that match the curriculum.

Finally, we give a concrete example of this process, that is, a sample ICT activity with complete documentation following the design process outlined in the paper.

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