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Report

Mathematics, technology and homework for 11-14 year old pupils

The focus of this research was concerned with mathematics education – its practice for the 11- to 14-year-old-age range, how technology can be used to support teaching and learning for this age group, and the roles of homework in this context. The aim of the study was to make a comparative analysis of reasons for the importance and position of mathematics education in a national curriculum in England and Serbia, the ways homework can be involved and play roles in mathematics education. The ways technologies have supported those educational practices to date, are outlined and discussed.

It is quite apparent that ICT (Information – Communication Technology) plays a significant role in everyday life, shaping the modern society. Research of widespread ICT usage in the education sector shows a positive contribution to teaching process, cognitive activities of students and learning output. But understanding the complete role that modern technology have in education in one society is not possible without understanding the process of development teaching practice and methods of application of ICT. Research findings indicate that teacher have a strong desire for technology enhanced education, but they encountered many barriers (lack of confidence, lack of access to resource include both software and hardware, technical support, etc.). It is clear that new technologies have the potential to support education across the curriculum and provide opportune for effective collaboration in learning process. For complete understanding which role ICT have in the teaching of mathematics it is necessary to observe the broader context of society and education.

However, when it comes to mathematics classes, especially with abstract mathematical topics, this is not an easy task. Teachers can use the most modern technology and educational software to present abstract mathematical concepts in a virtual environment (e.g., using computer software) in which students feel very comfortable. In this way, the space where students are accustomed to playing and having fun is turned into a space where in students can be free to explore and to learn. Classes were formerly designed to fit the needs of the average student, and this was another drawback of the traditional education system. The use and implementation of multimedia and educational software classes may significantly contribute to the modernization and individualization of learning. The focus of the teaching process has indeed shifted away from teachers and teaching materials, towards the student and learning materials.

A key question for this research was whether there is a role for digital technologies in supporting mathematics education, and the homework of mathematics education in particular. Certainly there has been a long history of digital technologies being developed and used to support mathematics education. Tinsley and Johnson edited early conference proceedings focused on Information and Communication Technologies in School Mathematics. From that date, there were

technological developments that led to computer-based resources that covered an entire mathematics curriculum, notably integrated learning systems and on-line digital resource systems. A report for the Joint Mathematical Council of the United Kingdom listed a range of technologies that had been applied to the study of mathematics: dynamic graphing tools; dynamic geometry tools; algorithmic programming languages; spreadsheets; data handling software and dynamic statistical tools; computer algebra systems; data loggers, such as motion detectors and GPS; and simulation software. Most technologically-based resources to support mathematics learning, however, have not been developed for use in homework contexts, although there have been examples of resources used in these contexts (such as MyMaths, Mathletics, Education City or Espresso Education).

The focus of this research was to explore further this latter under-developed area; how technologically-based resources can be created and used to support mathematics learning through homework practices. The research explores this area in the following: an overview of the educational system, mathematics education and homework practices in Serbia; a more in-depth review of a specific research development in Serbia to provide facilities to support mathematics education through homework practices; a comparison of the practices and developments with those in the UK (England); and the drawing out of conclusions from the findings of the four previous chapters in the context of existing literature. From the details covering aspects of the same context in the case studies in Serbia and the UK (England), the research takes a comparative analysis approach, to identify similarities and differences. This comparative analysis and a consideration of the relationships of findings to existing theoretical frameworks, highlight how current developments in Serbia are taking forward not only teaching and learning practices in mathematics education for 11 to 14 year old pupils and their teachers, but also the concepts of relationships between formal and informal learning. By comparing the situations in the two countries, a range of key points arise.

- ***Mathematics as a subject in school is considered internationally to be important.*** Homework is considered in many countries to offer benefits for pupils and their education. However, there have been comparatively few studies that have focused specifically on homework in mathematics. Similarly, the use of technologies has been considered to offer benefits to pupils in their learning of mathematics.
- ***There are similarities in the school systems in Serbia and in the United Kingdom (England).*** Subject-based instruction is common for the 11- to 14-year-old age group in both countries. The testing of pupils in mathematics now occurs more regularly in Serbia than it does in the UK. However, teacher training is rather different; in Serbia teachers are trained largely in a subject domain, while in England teachers are taught about education and teaching practice to a greater extent. However, the school system in Serbia is undergoing a range of reforms and initiatives that are concerned with modernisation.
- ***ICT in schools has been relatively recently introduced in Serbia, while in England schools have been involved in using ICT for the past 25 years or more.*** However, in both countries, technologies are still being used to explore and address key educational problems. The later uptake of technologies in Serbia does not mean that creative developments are not happening. Indeed, the eZbirka development has focused on mathematics education and homework, while developments in technologies in other countries including England have not addressed this concern in the same way.
- ***What makes the eZbirka platform different from other technological solutions is the facilities that provide opportunities for pupils to record their solutions online, and the ways that these are then accessible to teachers, so that they can gain feedback about how well pupils are performing, and pick up on issues and problems that they face.*** The issues and problems that pupils identify can be referred to by teachers in subsequent lessons, so that misunderstandings or lack of techniques do not continue. In this way, reference to pupil issues and problems by their teachers is enhancing a vital need for learning. Pupils are asked to detail their learning as it is happening (importantly – at the point of trialling learning), and then they, with their peers or with their teachers, can reflect on this learning in order to support success and to address weaknesses. Pupils can also contact each other and participate in deriving answers to problems

they are set, so joint working is being encouraged; peer learning is being enhanced as a positive mechanism.

- ***The use of the eZbirka platform compares dramatically with the processes involved in the integrated learning system (ILS) approaches of the mid-1990s, where feedback and links to teachers and other in-class learning was not easily made.*** In an ILS, pupils produced answers to problems, but they were not asked to detail their solutions, or provide comment to their teachers on issues they faced. Teachers had access to a reporting system that indicated correct or incorrect responses, but no detail of where issues arose was collected at the time the problems were undertaken.
- ***The use of the eZbirka platform is clearly supporting concepts and practices of how formal and informal learning settings can be integrated rather than just linked.*** The value of this integration of informal and formal needs and practices is beginning to be identified through pilot research studies, and results to indicate that both pupils and teachers see value and benefits in the system. A small-scale pilot research study also suggests that mathematical results in tests are improving.

There have been few studies that have explored homework practices in depth, few that have explored these practices within the context of mathematics education and for 11 to 14 year old pupils. This research takes this exploration further, looking at these areas but also where technologies are being used. Findings indicate that ICT may well in this context be providing a more neutral medium, allowing pupils to reflect more 'coldly' on issues and challenges, which they might otherwise have difficulty in discussing in a face-to-face way. This medium takes an important step in moving concerns of pupils from 'the need to produce right answers' to 'a focus on processes of working, enabling them to describe their issues to support their future learning'.

As a result of the research conducted at the University of Lancaster:

- [1] Radovic S. (2014). Technology support education: Modernisation of mathematics education in Serbia. Seminar at Department of Educational Research. 12. November 2014., Lancaster University, United Kingdom.
- [2] Radovic, S., & Passey, D. (2014). Mathematics, technology and homework for 11-14 year old pupils: comparing developments in formal-informal practice in Serbia and the UK (England). (pp. 1-29). Lancaster: Lancaster University.
- [3] Radovic, S., & Passey, D. (2015). Learning Mathematics Across Formal and Informal Settings, submitted for publication EEE Transactions on Emerging Topics in Computing - Special Issue/Section on Emerging Trends in Education

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