The Difficulties Facing Technology Integration into Mathematics Education in Lebanon

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One of the major responsibilities of the math education community is to prepare students for the work place and provide them with the necessary expertise to effectively use the different technologies dominating it. The educational systems of many developing countries face difficulties in realizing this goal because technological advances in the twenty first century are taking place at a quicker pace than educational reform. In Lebanon, mathematics education has not fully benefited from the surrounding electronic technology rich environment due to the following reasons:

- Access to technology
- Lebanese mathematics curriculum
- Teachers' qualifications, beliefs and professional development.

In all that follows, the word technology will refer to technology associated to computers. Any other type of technology will be specified.

Access to Technology

Integration of technology in math education requires access to computers, educational software and internet. Such an access is not guaranteed in all the Lebanese schools. In Lebanon, there are schools that are well prepared to integrate technology into math education and they are doing that successfully, while there are schools that don't have computers yet. Financial matters play an important role in that respect. According to the statistics accomplished by the Center for Education and Research Development during the year 2006 (CERD 2006), the 2788 Lebanese schools...
Difficulties facing Technology Integration In Lebanon were divided in three categories: 1025 private schools, 1399 public schools and 364 free private schools. In 2006, the Lebanese students were distributed over these schools is shown on the chart here below.

![Distribution of Lebanese Students over the Lebanese Schools During the Academic year 2005-2006](image)

In the public schools, learning is open to every student with a tuition fee that does not exceed $70 per year and they have a full financial support from the government. Unfortunately, financial difficulties has deprived many public schools in Lebanon from getting computers, but the ministry of education is doing its best to overcome this problem and has distributed almost 8000 computers to the public schools last year. The situation in the private schools is different since students' tuition fees range from $300 to $10000 per year which insures a sufficient financial support for these schools (but not all of them). Consequently, many (but not all) of these private schools have financial abilities and they are integrating information technology into math education. There is not a study done on a nationwide scale that concerns the number of computers available at each school and whether these computers are used in mathematics education.

Usage of graphic calculators is also not accessible to all Lebanese students because graphic calculators are expensive.

The provision of computers, software and graphic calculators does not really imply technology integration in math education if it was not accompanied by a curriculum reform.

**Lebanese Mathematics Curriculum**

The first reform in the Lebanese Mathematics Curriculum (LMC) took place after 25 years of war in Lebanon was in 1997. In this curriculum, recommendations to use a graphic calculator or an appropriate computer
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program took place twice: once in grade 11 for controlling the graph of the representative curve of a function (CERD 1997 p. 251) and the other time in grade 12 to help students visualize the parametric curves (CERD 1997 p.122). These two recommendations were not taken in consideration while applying the curriculum because not all the Lebanese students can afford to buy a graphic calculator and not all the schools had computers and computer programs to use them in teaching. Since 1997 and till now, the LMC was not updated. Mathematics in the LMC is still that topic dominated by abstract concepts, symbols and algebraic expressions. The different representations of concepts and especially the graphical ones are considered as principal goals of the curriculum and not as tools that facilitate learning as it is the case with the graphical representations of functions (CERD 1997, p.195). The numerical calculations of measures of dispersion and central tendency are still at the heart of the objectives of the statistics in the LMC while they can be performed by any simple scientific calculator nowadays. Such calculations are becoming a burden to the students who don't really appreciate to do what non sophisticated scientific calculators can perform if few seconds.

Few private Lebanese schools have the appropriate software to use in teaching, but they are unable to change the instructional objectives of the LMC because the Ministry of Education has the control over the structure and the content of the curriculum as well as over the official exams which every student attending grade 12 has to pass in order to graduate.

**Teachers' Qualifications, Beliefs and Professional Development**

"Technology can improve teaching and learning, but just having technology doesn’t automatically translate to better instructional outcomes" (SIIA 2000). The key to any successful reform in mathematics teaching and in particular with respect to technology integration in teaching are the teachers themselves (Kaput 1992, NCTM 1989, 2000). They are the ones who effectively decide when and how to implement any change in the curriculum and what technologies to use.

To be able to implement technology, teachers must have a mastery of the mathematics content, of the pedagogical skills and the technology used. Some Lebanese math teachers are highly qualified content, pedagogical and technology wise, but many as well are not.
The main problems facing teacher professional development are: financial problems, time constraints, teachers’ own beliefs about technology integration in math education and the type of workshops designed for technology integration in math teaching.

The financial issues are not only reflected on equipping school with the necessary number of computers and the convenient software, but on the schools’ budgets assigned to teachers’ professional development. Concerning the private sector, there is only few schools in Lebanon that fully support their in-service teachers’ professional development, while the others partially support or don’t support it at all. Concerning the public sector, the ministry of education organizes free workshops for teachers in the public sector that range from teaching the teachers the basics needed for using the computer to developing a project based learning using computers. However, not all teachers in the public sector have the chance to participate in such workshops. In brief, most of the in-service teachers who seek professional development have to financially support the offered workshops themselves. The economical difficulties in Lebanon prevent them from participating in these workshops. In addition, if these teachers learn how to use a certain software, they won’t have the chance to practice using and applying it because the software is not available at their schools.

Time constraint is a real problem that prevents teachers from participating in workshops and integrating technology into math teaching. Being bounded to official exams exerts a pressure on math teachers who have to cover large amounts of content in a limited period shorter than the usual academic year. This time constraint prevents them from integrating technology because it will be time consuming especially for those who have a lack of expertise with using computers and software. Another aspect related to time constraint is the timing of the professional development workshops. The majority of such workshops take place in the afternoon. Most of the Lebanese teachers have a full teaching load and they can’t leave their schools early. Also, most of the workshops take place in the capital Beirut and teachers must have a whole free afternoon to be able to attend a certain workshop.

Among the difficulties facing math teachers’ professional development concerning technology integration is the type of workshops they receive and
the availability of necessary software. Many of the workshops teach about the technology itself rather than how to apply the technology in class. Such workshops are necessary for those who don’t know how to use certain software and they should be followed by practice to succeed. These teachers don’t have the opportunity to practice the skills they have learned in these workshops and to find ways that help integrate technology in their teaching because it is not available at their schools. Only few workshops taking place in Lebanon address an expert audience in using technology. In such workshops, the main goal is usually the application of such technologies in class.

The most important factor that helps technology integration in class is teachers’ beliefs about that. Many teachers still believe that their explanations are sufficient for students to learn and understand concepts and that technology is time consuming. These teachers still don’t believe in the effect of technology on students’ learning. This is related to their education about technology, to their proficiency in applying technology and the way they have learned math. The majority of the teachers who teach mathematics have learned math in the traditional manner without having technology incorporated into their learning. The Strategic Educational Document developed by the Center for Research and Development 2006 have shown the following results concerning teachers’ convenience (the term convenient in this study refers to “holds a university degree in the domain of mathematics or has graduated from faculty of education”) to teach mathematics:

<table>
<thead>
<tr>
<th></th>
<th>Public Schools</th>
<th>Private Schools</th>
<th>Free Private Schools</th>
</tr>
</thead>
<tbody>
<tr>
<td>Convenient</td>
<td>24.10%</td>
<td>36.10%</td>
<td>29.00%</td>
</tr>
<tr>
<td>Inconvenient</td>
<td>75.90%</td>
<td>64.00%</td>
<td>71.00%</td>
</tr>
</tbody>
</table>

![Distribution of the 9416 math teachers in the first cycle during 2006-2007](image)
According to the results presented here before, almost 70% of the mathematics teachers in the elementary and middle school are considered as inconvenient to teach mathematics, while this percentage decreases in the secondary school. Such an inconvenience prevents technology integration in mathematics teaching. Most of the teachers who don't hold a degree in mathematics haven't learned mathematics with technology tools and haven't received training to integrate technology in their teaching. A direct consequence of that is feeling uncomfortable with the use of technology in math teaching which leads to avoidance of technology integration in math teaching due to the lack of knowledge about the technology itself and about the important role it plays in math teaching. The results of a study by Arouni
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(Arouni 2005) on 100 mathematics teachers that hold a B.S. or a higher degree in mathematics showed that lack of training is also one of the causes that prevent these teachers from learning about new technologies and integrating them into their teaching.

Suggestions That Help Technology Integration in Mathematics Teaching

The National Council Of teachers of Mathematics (NCTM) has recognized technology as one of the Principles for School Mathematics:

"Technology is essential in teaching and learning mathematics; it influences the mathematics that is taught and enhances students' learning"

(NCTM 2000. p.24)

Technology changes the way mathematics is done today as it allows the visualization of abstract concepts and ideas. It brings certain utility and functionality that can not be achieved without it. It allows a differentiated instruction (Schneiderman, M. 2004) as it caters for different learning styles. The influence of technology is not limited to the mathematics that is taught, but it is also extended to what is taught and when a topic should appear in the curriculum (NCTM 2000, p.26). Consequently, when technology is going to be integrated in any curriculum, it should be accompanied by a curriculum reform aiming at enhancing mathematics learning and teaching with technology rather than teaching about technology (Garofalo J.et al. 2000, Kaput, J.J. 1992).

Before proceeding in any future reform in mathematics that integrates technology into math teaching in Lebanon, access to resources and technology should be feasible and easy. For that purpose, schools should be well equipped to apply this reform and technology implementation in math teaching should be one of the major items on any school's agenda. A part of any school budget should be devoted for buying computers and software or updating their computers. Another part of schools' budgets should be consecrated for teachers' professional development. To guarantee an easy teachers' and students' access to computers, this issue should be considered when schools time tables are prepared. If it is not possible to have all schools
supplied with computers and software, then the other option would be the usage of graphic calculators which will be cheaper than school preparation for integration of technology, but still too expensive for many students to buy. In this case, schools should consider buying several calculators and renting them to students who can't afford buying them.

One of the challenges that the Lebanese Ministry of Education will face in case technology is integrated in math education is to ensure that all schools have the necessary and convenient software to use. It is recommended to decide on the types of software to be used and supply schools with these software with a reasonable price or for free. Once technology is integrated in the curriculum, assessment methods will change. Lebanese official exams, in particular, will be affected by that and this guarantees that all the schools will apply the changes to meet the requirements of the official exams.

Technology and Curriculum Reform

Integrating technology in math education in Lebanon will create a crucial change in the learning objectives of the curriculum. Once different representations of the same concept are not treated as objectives, but as tools to facilitate learning and the tedious calculations are minimized, content will change from focusing on procedural and algorithmic skills to a content that emphasizes a deep understanding of concepts and students will have the ability to make decisions in mathematics and apply the math they learn to real life situations. Any work on curriculum reform aiming at integrating technology in math teaching can benefit from the work of Garofalo et al. for promoting appropriate uses of technology in mathematics. They had devised a set of guidelines to shape the development of mathematics activities and materials. These guidelines are:

- introduce technology in context
- address worthwhile mathematics with appropriate pedagogy
- take advantage of technology
- connect mathematics topics
Technology should be introduced and illustrated in the context of meaningful content-based activities that address worthwhile mathematics concepts, procedures, and strategies and interconnect mathematics topics and connect mathematics to real-world phenomena. These activities should take advantage of the capabilities of technology, and hence should extend beyond or significantly enhance what could be done without technology. Multiple representations of mathematical topics should be incorporated in these activities to help students translate among the different representations of the same concept and acquire a better conceptual understanding of the topic (Garofalo, Shockey, Harper, & Drier, 1999).

**Teachers' Development**

The main goal of any reform in mathematics is the improvement of the quality of teaching and learning. Reviewing the math curriculum and providing schools by computers and software is not sufficient to successfully integrate technology into math teaching and improving the quality of learning. The mathematics teachers' beliefs about the integration of technology which is reflected in their teaching practices and the way they adopt technology play an important role in the success of a reform that integrates technology in teaching.

Changing Lebanese mathematics teachers' beliefs and attitudes towards technology needs time and it should start by teacher development. Teacher development has to be an ongoing process that focuses on: the affect of technology integration on the quality student learning and understanding, and on teacher training to use technology.

To change their beliefs about technology integration, teacher development must: provide teachers with opportunities to reflect on their own beliefs (Borko & Putnam, 1995, 1996; Bransford & Schwartz, 1999), allow teachers to experience the value of technology integration in math teaching by having an access to others practices and beliefs that are reflective of their subject and grade level, and observe the positive impact these practices have on students’
learning (Richardson & Placier, 2001; Sandholtz, Ringstaff, & Dwyer, 1997) and that will lead to reform over time.

To use technology efficiently in math teaching, teachers should be well trained to use technology in teaching so that they will have confidence in their abilities while using technology in class. A priority in this teacher training should be: the connections between subject matter and pedagogical content, and the emphasis on learning about technology in the context of subject matter and pedagogy. This will help teachers to understand conceptually the potential for technology in their daily professional lives. When teachers learn isolated technology skills, they tend to forget them with time. When they learn technological skills that are related to the curriculum they teach and to the technological tools they have access to, teachers can practice what they have learned and that will increase their use of technology to support instruction and student learning. (Hughes, 2004). To get the maximum benefit from teacher training, they should be complemented by mentoring sessions inside the classes.

Prospective teachers’ professional development and preparation are also important issues that have a significant impact on technology integration in math teaching, but such issues will not be discussed in this paper.

Finally, teachers themselves must take initiatives in their professional development. According to the NCTM:

*Mathematics teachers must develop and maintain the mathematical and pedagogical knowledge they need to teach their students well. One way to do this is to collaborate with their colleagues and to create their own learning opportunities where none exist. They should also seek out high-quality professional development opportunities that fit their learning needs. By pursuing sources of information, building communities of colleagues, and participating in professional development, teachers can continue to grow as professionals.* (NCTM, 2000, p. 373)

**Conclusion**

"Education technology is neither inherently effective nor inherently ineffective; instead, its degree of effectiveness depends upon the congruence among the goals of instruction,
characteristics of the learners, design of the software, and educator training and decision-making, among other factors"
