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IS EDUCATIONAL TECHNOLOGY USEFUL TO MATHEMATICS TEACHERS ACTIVISTS?

Dorian Stoilescu

Abstract: This in-progress study presents aspects of using educational technology in teaching mathematics education. More exactly, it explores ways in which educational technology might be used in order to improve teachers' cultural awareness and social activism. A rationale for a qualitative research study is presented by using multiple methods combining action research and multiple case studies. Three high school mathematics teachers from Greater Toronto Area are selected to participate in this research. Actor Network Theory (ANT) was considered as research paradigm for this study.

Key words: Educational Technology, Teacher Activism, Mathematics Education

1. Introduction

Canadian learners and teachers continue to struggle with issues related to social justice and activism. These issues are further complicated by attempts to enhance the pedagogical effectiveness of various disciplines with new technologies. For example, where questions of social justice were previously considered totally separated from mathematics education, since the former aims of mathematics teachers were restricted to abstract processes that ignored social processes and knowledge transfer, when the advent of technologies applicable to the classroom were introduced, a socio-political element to the teaching of mathematics has been developed. This movement is most apparent in the various attempts to incorporate educational technologies, and mathematics education is one of them. Educational technology has been an important mediator that significantly modifies the learning environment and teaching approaches and, therefore, among constructivists and others there have been ongoing debates about whether mathematics teachers' use of technology in classrooms can actually help students and teachers to perform better.

The recent Ontario Curriculum for Education in Mathematics (Ministry of Education, 2005, 2007) offers some orientations to study mathematics considering various social and cultural aspects, has some guidance for social justice, and gives directions for learning considering multidisciplinary approaches. However, these reforms cannot be implemented easily. As Fullan (1993) mentioned, when new educational programs are implemented, the results take directions that are fairly different from the initial intentions. Therefore, these recent Ontario reforms in mathematics curriculum are expected to encounter difficulties when they are implemented in a wide variety of schools.

Context of the Problem

It is my premise that part of the solution to this problem lies in re-examining ways of teaching mathematics by using educational technology in order to promote social activism, and also, renegotiating relations between teachers and students in mathematics classrooms. Freire (1973) mentioned that "the role of educator is not to 'fill' the educate with 'knowledge,' technical or otherwise. It is rather to attempt to move towards a new way of thinking in both educator and educatee, through the dialogical relationship between both" (p.125). As such, the goals of this research are:

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- To document and analyze teachers’ choices in educational technology use with regards to promotion of social activism;

- To explore existent pedagogical development ideas and pedagogical activism in mathematics education;

- To propose a research methodology that explores mathematics teachers' challenges in using educational technology.

More exactly, I will be designing a qualitative research study to explore the use of educational technology in order to foster social activism. I will develop a poststructuralist methodology based on actor network theory, which is one of the possible perspective theories that are capable of offering a sound methodological framework to this study. This will be designed as an ongoing investigation, exploring the shifting body of knowledge that changes during the process of instruction in mathematics curricula.

This paper is comprised as follows. An introductory section presents an overview and the purposes of the research. In the second section, theoretical aspects in implementing educational technology in mathematics education are presented, discussing the complexity and the nature of contributions involved in order produce a social impact. The third section will highlight the main concepts from professional development in mathematics education and teachers activists. The methodology will comprise the fifth section and, in concluding the paper, I will articulate some of the limitations and draw some preliminary conclusions.

2. Issues in Implementing Educational Technology in Classrooms

Educational technology was praised for offering support for differentiated instruction, multiple intelligences, and constructivist teaching and learning (Kelly & Tangney, 2006; Stoilescu, 2005). Overall, educational technology might have positive benefits in classrooms if educators do not perceive it as a universal panacea and are knowledgeably adapting to the concrete settings (Kimmel & Deek, 1995; Ringstaff & Kelley, 2002). Although researchers pointed out that computers might be used in education to improve learning (Roschelle, Pea, Hoadley, Gordin & Means, 2000) and provide equity (Pea, 1997, 2004) is not easy to accomplish. For instance, Negropontes, Resnick and Cassel (1997) reported that poor pedagogical techniques are often found in educational technology. They noticed that digital technologies are used to present educational perspectives rather simplistically. Instead, the authors recommended that educational environments using computers should offer: a) direct explorations, b) direct expressions, c) direct experience, d) multimodal exploring, e) multicultural settings, and f) multilingual technologies.

Each of these factors is essential to addressing multiple learning perspectives, which is integral to ensuring an equitable classroom environment. As it can be seen, educational technology has received requests for offering support for equity and social justice. However, the universality of the benefits of technology in classrooms has not gone without major critics. The tendency to exaggerate these benefits of technology in American cultural life was harshly criticized by Postman (1995) who called it technological adoration. For example, he contested the present capability of technological products to be widely accepted by children with different ages and backgrounds. Cases were reported when top officials did not have realistic expectations, being not aware of children's specific ways of acting and reasoning. For him, most of the software products were designed for adults or elite children. Therefore, Postman contended, software designers and educational administrators failed to cooperate in order to produce adequate software programs. Since then, many new democratic software have appeared.

While technologies offer many new possibilities, in fact these might distort facts or amplify inequalities. For instance, using educational technology in teaching, Layton (1988) noticed that technology was often viewed as minimizing the accomplishments of scientific thinking, by superficially and mechanically modelling scientific reasoning. Also, many software products are biased against women and minorities (Chuck, 2002; Friedman & Nissenbaum, 1996) and sometimes the prices for many software and hardware products are prohibitive for many schools and universities

(Moyle, 2003). In shaping the ways computer technologies were used, socio-economic status (SES) was found to be an important factor. Becker (2000) and Warschauer, Knobel and Stone (2004) mentioned that high-SES students are more likely to use computers because they afford to have a better technical and human network support. Also, they mentioned that students of English as a Second Language (ESL), usually placed in schools with low-SES, are less likely to use computers home than their English native speakers' classmates. Warschauer et al. found that high-SES students benefit more academically from having home computers technologies than do low-SES students. These findings were supported by studies developed by Attewell and Battle (1999) and Cuban (2001). As for students with low-SES, they are highly probably to be directed more into skill drills training than for fostering complex thinking (Warschauer, 2002).

There have been several attempts to ease these aspects of affordability and make the hardware and software less expensive and increase the potential of openness and democratic agency. For instance, the price of hardware and software dropped significantly in the last decade. Also, more software (e.g. Linux, Web 2.0 technologies) became open designed software, cheaper, allowing more transparency and openness. With all of these attempts, these reforms are not yet systemic, these changes being made rather by few early adopters of technology.

In teaching mathematics, educational technology has a proven track record of enhancing teachers' ability to cover multiple subjects with increasing precision. In particular, this is demonstrated in new pedagogical approaches in classrooms' work and inquiry (Hoyles, Noss, & Kent, 2004) which include more accessible classroom environment. No longer is the classroom geared toward specialized students or those geared toward a career in mathematics. Technology has made it possible to conduct classrooms simulations and projects in mathematics in ways more relevant to the daily experiences of students of different background and different locations.

3. Professional Development in Mathematics Education

In professional development, isolation has been viewed as a great danger for teachers. If teachers become isolated (Sachs, 2003) they will have more dull routines in their practices. Moreover, they will tend to be hostile to any new challenges to their established practices. Therefore, new professionalism policies should create opportunities for teachers to avoid separation and take responsibility for practical actions (McLaughlin, 1997). Another danger for professional development represents imposing managerial and commercial agendas in teaching. Public school systems from Canada, Australia, the UK and the US have been scrutinized for these managerial agendas. These attitudes often regard public services and infrastructures as inherently inefficient and require them to be reformed by applying management laws such as effectiveness, efficiency and economically-based accountability.

The way mathematics should be taught to students has been an ongoing debate. As Wenger (2003) stated, students are "born of learning but they can also learn not to learn" (p. 80). Arguing against the ideas of pupils being passive receptacles of acquiring knowledge for mathematics, educational researchers tried to affirm new identities for learners by emphasizing the students' active participation in the construction of knowledge (Taylor, 1994). Trying to engage students in examining hypotheses in mathematical classrooms and facilitating students' abilities to build their own knowledge Lampert(1990) emphasized that these approaches are very different from traditional school mathematics.

Another problem in professional development is implementing centralized directives and policies without consulting local structures. Often teachers are required to implement content and strategies developed by ministries or universities that did not involve teachers in the design process. Models such as top-down implementations, centre-to-periphery, and research development diffusion adoption (RDDA) have been criticized as widening the gap between theory and practice. These reforms left teachers outside the innovational efforts (Barnett & Hodson, 2001). Viewing professional teacher responsibility as being accountable for performances and standardized students' tests were viewed by Apple (1998) as enforcing deskilling, deprofessionalization and deauthentication of teachers.

Efforts to teach mathematics and science are not always related with social concerns. In teaching social scientific issues, Lortie (1975) mentioned tendencies of teachers who studies hard sciences to ignore social issues and to believe that scientific content is non-negotiable and isolated from day-to-day social concerns. Therefore, argued Lortie, because of their academic formation, science and mathematics teachers tend to disregard social activism and believe is not appropriate for teaching. The importance of transmitting teaching achievements and making them valuable for the whole school was noticed by Fullan (2001). He recommended that staff development lead to improvement of school organization and not only to improvement of the individual skills of teachers. Therefore, efforts should not be focused on training specific or isolated skills. Professional development programs need to be grounded in teachers' work, their feelings, experiences and interactions with communities. An example in this sense is the model proposed by Marx, Blumenfeld, Krajcik and Soloway (1997) called CEER (Collaboration-Enactment-Extend-Reflection) that helps teachers adapt constructivism innovations to community settings: a) collaboration with others; b) enactment of new classroom practices; c) extended efforts to instantiate change, and d) reflection on practice.

Kaput, Noss and Hoyles (2008) consider that technology attracts mathematicians and mathematics educators because it is offering an empowering representational infrastructure for simulation, visualisation, and modelling for both adults and children. Kaput et al. (2008) mentioned that technology might be used to improve mathematics education by "enlarging the limited processing power of human minds affording new domains of knowledge with new representations to populations who previously did not had access." (p. 713)

This professional development model focuses on teacher involvement in the community. Also, professional development requires teachers to be for community (Hargreaves, 2000). In a democratic country, teachers have to act in order to eliminate or reduce inequities and oppressions such as poverty, racism, sexism, and ableism. The fact that the teaching profession is inevitably a social and political act was substantiated by Hargreaves (2000), Hodson (2003) and Sachs (2001). As Hodson (2003) mentioned, acquiring basic knowledge: is inextricably linked with education for political literacy and with the ideology of education as social reconstruction. The kind of social reconstruction I envisage includes the confrontation and elimination of racism, sexism, classism, and other forms of discrimination, scapegoating and injustice; it includes a substantial shift away from unthinking and unlimited consumerism towards a more environmentally sustainable lifestyle that promotes the adoption of appropriate technology (p.660).

4. Methodological Considerations

This study is based on qualitative research and employs multiple methods. The primary methods combine action research and multiple case studies. The first part of this section outlines the rationale for the qualitative research. This is followed by a description of the action research and multiple case study methodologies. Next, data collection and data analysis are described. Also, I will describe why I intend to use Actor Network Theory (ANT) as a possible research paradigm of this study. In the end, strategies of trustworthiness and validity will be addressed.

The followings main research questions are asked:

1. What are the teachers' experiences and attitudes towards using technology in teaching social issues in mathematics?

2. How can educational technology be used in order to increase teachers' social activism?

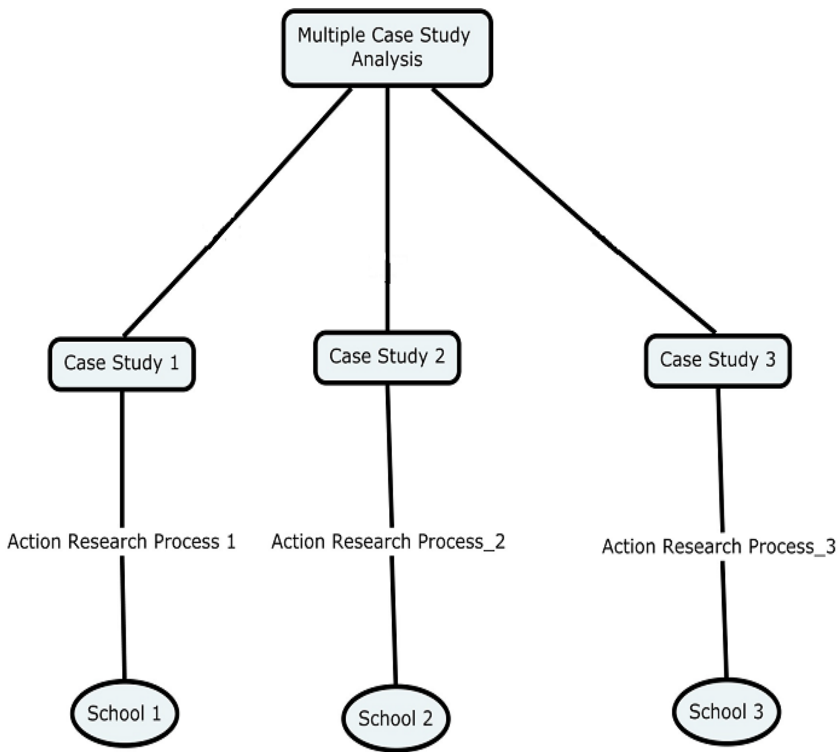
Research Context

The research takes place in three different high schools from the Greater Toronto Area. The classrooms' settings are different and so is the role of the teachers. This research uses a hybrid of rationalistic and naturalistic approaches (Lincoln & Guba, 1985). It is believed such an approach is more authentic and feasible in the specific contexts where secondary teachers present mathematics curriculum. Furthermore, it may suggest a superior approach of determining the ways in which the incorporation of technology into teaching practices may improve interactions and functionality.

However, it should be noted that this research does not seek universal solutions. Such solutions may work case by case, but a 'one size fits all' perspective has many failings. At the very least, it presumes a uniformity of context and character that is difficult to justify.

The mode of research intended involves the placement of the researcher in each of the contexts that will be investigated. This placement means the researcher takes an active role. For example, if a teacher decides to use a specific technology during his or her mathematics classes, I will assist them with technical support and by providing the opportunity to reflect at their practice. Participants will be recruited from mathematics teachers currently involved in mathematics activism. Three teachers from middle and secondary schools will participate in this study. Each are expected to have over five years of experience in teaching mathematics education, as well as a background in mathematics that includes experience using technology in their research and teaching practices.

The research process is a multi-method qualitative research composed from participatory action research and multiple case studies. This research approach might be summarized according to the following scheme:



Picture 1. ***The Main Research Process***

The process will be deductive-inductive (Merriam, 1998) and will include two to three repetitions of the research cycle. These repetitions should insure the integrity of the results. This findings will eventually assist in improving educational technology skills for providing social activism.

The Role of Action Research

Action research (Lewin, 1946; Stringer, 2004) offers the potential to liberate classrooms from top-down directives, explore authentic teaching and learning contexts, and enable teachers to develop their strategies. Teachers assess curricula and pedagogical practices in terms of the immediate demands of particular teaching and learning situations. The social principles that inform action research look beyond these demands and do not have a technical or ritualized form. According to Stringer, action research has the following four main characteristics: a) democratic, b) participatory, c) empowering, and d) life-enhancing.

The process of action research is a repeated cycle of Look-Think-Act. Although this seems simplistic, it actually provides philosophical directions and thus as appropriate to this project. Among these directions, it offers a critical basis to develop effective professional development programs (Stringer, 2004) and capitalize on the reflective capacity of the participants.

According to Stringer (2004), "participatory research provides a technical means for accomplishing both a sense of community and a living democracy" (p.33). In this research, attention is focused on criticizing, challenging, modifying, and changing teachers' beliefs, understandings, attitudes, skills, values, and relationships, rather than on providing curriculum information. It is assumed that teachers can acquire the expertise necessary for effective curriculum development by refining and extending the practical professional knowledge they already possess through critical collaborative activity supported by a researcher/ facilitator whose work involves fostering critical awareness, enhancing curriculum problem-solving skills, and assisting the group in working through conflicts. The overt goal is to merge the roles of researcher and teacher; teachers act as researchers and researcher undertake some of the teaching. The process of action research looks at: a) relationships, b) communication, c) participation and d) inclusion.

The Role of Researcher

The researcher will be participant–observer. My main contribution is to discuss with mathematics teachers the different modalities entailed by the use of software in implementing social activism. Teachers' practices vary according to setting. Therefore, I will spend a considerable amount of time reading different curricular and educational research literature for the purpose of designing various solutions required by the AR group. My role will be multi-layered. I mentioned already my role as facilitator. In addition, I am providing technological expertise for the group. I offered to be a resource person able to provide and link technical solutions with different curricular modules. Also, I am required to be a reflective teacher and a critic able to evaluate group activities in order to readjust and redesign the technology and the social pedagogy. In the first stage of the group building openness and the sense of sharing are essential.

The Role of Multiple Case Studies

"Case studies concentrate attention on the way particular groups of people confront a specific problem, taking a holistic view of the situation" (Shaw, 1978, p.2). Merriam (1998) describes three types of case studies: descriptive, interpretative, and evaluative. Descriptive cases use existing theories for the purpose of studying samples to detect differences relative to the theory. Interpretative cases analyze facts in order to create a new theory. Finally, evaluative cases combine the previous two, updating a theory and incorporating judgements at a final stage. This inquiry allows researchers openness and enables them to use a variety of models and techniques according to the particular settings. The theory will be updated after comparing concrete facts and aspects from the three case studies studied. Merriam recommends considering multiple case studies in two stages of data analysis. The first stage consists of within-case research whereby each case is treated extensively and in isolation. After the temporary findings are released, the second stage begins. This period is called cross-case analysis. Data, contexts and findings are then compared across cases.

Data Collection and Analysis

In action research, data collection and analysis are not separate stages, but interrelated in on-going processes. Data will be collected from interviews, action research meetings, observations in classrooms, and document analysis. This will cover at least two units of curriculum or two projects. Since action research requires on-going analysis (Mills, 2003) rendering conclusions prematurely should be avoided. Preliminary observations will be made through fieldwork conducted in mathematics classrooms. The first major stage is to identify major themes that emerge in the literature review and the data collection performed during field research. Once the results of these activities have been collected they will be listed and analyzed to see if they correspond to current findings.

For data coding, I will use adapt a classification defined by Hodson (2003) to analyze social awareness. This classification uses four levels of social participation and describes the degree of involvement in social transformations:

1. Recognizing the societal impact of mathematics and technology,

2. Acknowledging that mathematical, scientific and technological decisions are driven of particular interests and power,

3. Having own positions and expectations,

4. Being prepared to do action effectively.

Validity and Credibility Issues

For credibility and validity, Lincoln and Guba (1985) recommend to persistently pursuing the followings: a) prolonged engagement; b) persistent observation, c) referential adequacy, d) member check, and e) triangulation. I will follow all of these recommendations mentioned by Lincoln and Cuba. Considering types of triangulations used in qualitative research, I will use three distinct types of triangulation recommended by Patton (1990): a) data triangulation, b) triangulation through multiple analysts, and c) theory triangulation. More exactly, for data triangulation I will check if information from different sources of data (interviews, observation, meetings, documents) confirms each other. Multiple analysts' triangulation will be used by systematically meeting with my thesis committee and outlining temporary findings. Also, the thesis committee will have access to the entire data. Very important in this research is theory triangulation. In my case, I will see if the theoretical findings from different sources correspond. In addition, I will discuss the findings with participants to see if there are major discrepancies.

5. Analysis Lens and Ontology Informed by Using Actor Network Theory

Actor network theory does not presume any preestablished concept of the subject or the locations within which agency is expressed. Thus, it is informed by poststructuralist ideas that regard humans, nonhuman entities, and any composed group as semiotic actors linked in a non-foundational network that operates in a non-linear causal manner. Overall, the network is considered as having processes rather that causes or effects (Latour & Woolgar, 1986). It studies the interactions between social and technology and constantly threats traditional categories (Latour, 2005). Any actor is situated in a heterogeneous network and produces a specific trace that does not have a predetermined existence. As mentioned, even non-human entities (e.g., computers, smart boards, software, textbooks, blackboards, etc.) may be considered as actors.

In this research, my preliminary intention make me interested to approach ANT in order to study the interactions between technological products, students and teachers to see if they are produce social activism and how. Importantly, this approach rejects a priori concepts of legitimate models of mathematics teaching and the use of social activism and educational technology agents that are used to produce mathematical and social achievements. There are also other alternatives that might be considered for this study such as activity theory or critical discourse analysis. Since I am initially relying on Actor Network Theory (ANT) to analyze data, I will test its applicability by contrasting it with possible alternatives. If one of the alternatives proves superior, then I will adjust my analytical framework accordingly.

6. Preliminary Findings and Concluding Comments

This in-progress study will have several limitations. Being based on literature review and only three case studies of teachers will limit somewhat the generalizations of the findings. Also, as we mentioned before, this study were designed for mathematics teachers involved in social activism. Therefore, these findings and recommendations might not be valid for teachers who are not interested in social issues or have social approaches but without social activist stance. However, as we mentioned before, some findings can be extended for any teachers involved in mathematics activism.

This study might reveal how social activism can link with technology in mathematics education. The specific of this approach is finding practices and recommendations able to foster the interplay between these two fundamental aspects. The investigation became already challenging, first in finding to recruit such participants. While I tried to contact mathematics teachers able to participate in this research, there were three important obstacles that might put this research in peril:

a) Teachers who had a "traditional perspective" of teaching mathematics. This means, technology and social issues were both ignored by such perspectives.

b) Teachers who had a "technological viewpoint" that might easily overlook social issues. In this case the research might ignore social aspects of the classroom, and focus more in technological aspects of delivering mathematical content.

c) Teachers who take a "traditional social activism" approach. In this case, although teachers might have social awareness, they usually might miss the technological approach of delivering mathematical content.

Overall, finding teachers able to provide a successful interplay between using technology and including social issues in teaching mathematics is quite challenging. So far, I noticed only one teacher teaching at the middle level that fully accomplished both requirements (technology and social activism) and might be willing to participate in research. The study might therefore be changed further to only one case study of mathematics teacher using technology in social activism.

This study can prove advantageous in several ways. As action research, these projects are praised for providing participants multiple professional and social development benefits (Stringer, 2004) and will add to the body of action research in mathematics education. Most significantly, it can lead to valuable insights into improving the incorporation of educational technology into mathematics education through social activism.

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Author

Dorian Stoilescu, University of Toronto, Toronto, Ontario, Canada

e-mail: dstoilescu@yahoo.ca or dorian.stoilescu@utoronto.ca