Humans with Media: a performance collective in the classroom?

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INTRODUCTION

Authors such as Noss & Hoyles (1996) and Borba & Villarreal (2005) have stressed, to different degrees, how the use of different media change the mathematics produced. As different software designs become available, different mathematics can be developed. The classic examples are related to the teaching and learning of geometry (Laborde, 1998), functions and calculus (Confrey & Smith, 1994). The availability of dynamic geometry software can transform the types of tasks that can be developed in the classroom. For instance, problems can be assigned in a way that encourages students to try out different constructions and see if there are invariants after dragging a figure. The coordination of multiple representations as a way of knowing different aspects of functions and other calculus topics was also transformed as different software became available. For instance, Confrey & Smith (1994) argued about the importance of the software design for learning. In the case they analysed, they showed how the design of Function Probe, which allows for a graph of a function to be dragged, offered students new possibilities for coordinating representations. Being able to drag a graph and see the change in a given table of x-y values of the original function was a way of bringing the transformation of functions to the forefront. The influence of humans in a given software make it possible for it to shape the way other humans would learn.

More recently, Borba (2004) expanded on these ideas with the conjecture that mathematics also becomes transformed as we move from a face-to-face context to online distance courses for teachers. For instance, there are online environments in which writing in a chat or in a forum is the only way for participants to communicate among themselves. Analysis of an on-line course offered for mathematics teachers showed how writing shapes the mathematics discussed in this context. A comparison was made to show differences and similarities between solutions to a similar problem presented in a face-to-face classroom and an online course. The analysis was carried out based on the idea that when technology changes, the possibilities of mathematics are also altered. This is the principle idea behind the notion that a collective of humans-with-media constitutes the basic unit that produces knowledge. Knowledge is produced by humans, but also by different media such as orality, writing, or the new modalities of language that emerge from computer technology.

> We believe that humans-with-media, humans-media or humans-with-technologies are metaphors that can lead to insights regarding how the production of knowledge itself takes place (…). This metaphor synthesizes a view of cognition and of the history of technology that makes it possible to analyze the participation of new information technology 'actors' in these thinking collectives[1] (Borba & Villarreal, 2005, p. 23).

For instance, interactions take place in online courses using chat that include no form of orality, and this transforms the nature of the mathematics produced in such environments. One can also consider the classical example, of how the presence of software in the classroom changes the nature of the teaching of geometry, functions or calculus. In this talk, I will explore a different possibility of the theoretical construct humans-with-media. Can we consider that different media may change the nature of the performance in the classroom? Performance, in this case, is borrowed from the Arts, from Theater. If we see traditional classrooms as composed of a stage, occupied by the teacher who is delivering a monologue with students as the spectators, how can different media contribute to different kinds of performance in the "classroom arena"?

In this paper, I will discuss how media has shaped the notions of problem and knowledge, and I will outline a trend in thinking regarding how technology has shaped different forms of arts. I will make an exercise of looking into the near future, conjecturing about some possibilities regarding how the Internet can transform both arts and mathematics

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[1] Thinking Collective is a term used by Lévy to emphasize that knowledge is produced by collectives composed of humans and non-humans actors.

classrooms. After that, I will show how analyzing one of the influences of the Internet in education can provide us with a new perspective on practices that are already taking place in face-to-face classrooms.

PROBLEM AND MEDIA

Elsewhere I have discussed in detail how the notion of humans-with-media alters the way production of knowledge is seen and the way people collaborate (Borba & Villarreal, 2005; Borba & Zulatto, 2006). I believe that the very notion of problem is transformed by media. Saviani (1985) and Borba (1994) stated some time ago that problem has both an objective and a subjective part. The objective part is an obstacle, which emerges within the life experience; but an obstacle can pass unnoticed by one person and provoke considerable interest in another, and this is what I refer to as the subjective part. I believe it is time to extend such a discussion, and emphasize that a problem also depends on the medium that is available in a given collective. Studying function with paper and pencil only is one thing, and with a graphing calculator another. Many who studied function without access to computers could consider an obstacle, in the sense proposed above, to be "graph $y = x^2 - 5x + 6$".

Of course this is hardly a problem for collectives in which graphing software is present, since there is no obstacle to be overcome. As is well known, a 'typical problem' for collectives of humans-with-graphing-calculators is to explore relationships of graphs, tables and algebra as "a" varies $y = ax^2 + bx + c$, keeping "b" and "c" constant. I do not see problems as being inherently good or bad, but rather as conditioned by different media available. What is perceived as an obstacle and what provokes interest also depend on the media available. Subjectivity and objectivity are merged even closer by the notion of humans-with-media and the way the notion of problem can be transformed by it. In this example, there is another aspect to be considered; problems like the one above, with open possibilities of answers, are more likely to challenge the students if media, like graphing software, are available

But in many schools, even though calculators or software are allowed in the classroom, their use is not likely to be permitted during examinations. In particular, access to Internet may not be allowed based on arguments such as: you can find answers for the problems given, students may get distracted, or it will privilege students who know how to navigate better on the Internet. The above arguments are not based on research in which teachers or supervisors have been interviewed. They are just possibilities, based on similar arguments we have found in the past when calculators and software were first introduced as actors in the mathematics classroom. But as we try to look into the future, we can ask: what will become of the notion of problem if the Internet is allowed in the classroom? What kind of problems will be posed to collectives of humans-with-Internet?

It is very likely they will be quite different from those posed to collectives that include only paper-and-pencil as media, not only because the answer can be easily found on the Internet, but because Internet is also shaping the way we organize and see things. Finding something on the Internet can be more motivating for kids who belong to the 'Internet" generation. As I have discussed elsewhere (Borba, 2004), more and more kids do not see Internet as something new; they were born with it and they have no 'accent' to speak and listen to Internet language. If we consider that there is a new language being generated on the Internet, we can conclude that teachers learned this language when they were no longer children, and probably speak it with a strong accent, it not being their "mother tongue". "*Soon generations will be arriving in the schools, and next the universities, who have no accent, who, born, raised, and impregnated with 'Internet-ized', hyper-media texts, will expect educators so speak their language*" (Borba, 2004, p. 314, my emphasis). So I believe problems like those given in traditional paper-and-pencil environments will have to be, at a minimum, transformed into questions such as 'why is the graph of $y = x^2 - 5x + 6$ like this?'.

But we can also consider that we can transform the elaboration of a problem into a problem itself. Proposals of this type have been developed in Brazil and elsewhere under the titles of project work or modeling. In such pedagogical approaches, students are invited to choose a theme to study, to generate a question to be investigated, and elaborate an answer.

Students are, in this case, exploring part of the same process experienced by researchers. Internet in this case, seems to fit very well, and many researchers in Brazil such as Diniz (2007) and Borba & Malheiros (in progress) and Borba & Villarreal (2005) have documented and classified ways in which students used the Internet to develop their projects. We have also discussed what kinds of mathematics emerge from these projects, which are often interdisciplinary. Before I explore the synergy between modeling and the Internet, I will introduce another possible future form of problem.

Young people may begin to explore artistic perspectives in classrooms permeated by the Internet. Authors such as Boal (1979) have presented alternative forms of theater and performing arts by emphasizing the end of the separation between actors and audience. In this conception of theater, these roles, which are traditionally well defined, become blurred. From a different perspective, Kress (2003) has emphasized that radical changes are taking place as multimodal language – which joins together writing, pictures and animated videos – is becoming the common trend in the virtual world. I have borrowed both ideas to support the argument that a new kind of problem, which exploits the resources offered by the Internet, is what some of us have called digital mathematical performance (Gadanidis, 2006; Gadanidis & Borba, in progress). In such a perspective, we see that multimodal language can be used to develop mathematical ideas that can be posted on the Internet. For example, the waiter problem, which can be viewed at *http://www.edu.uwo.ca/dmp/,* is a sample of the type of projects that students can produce.

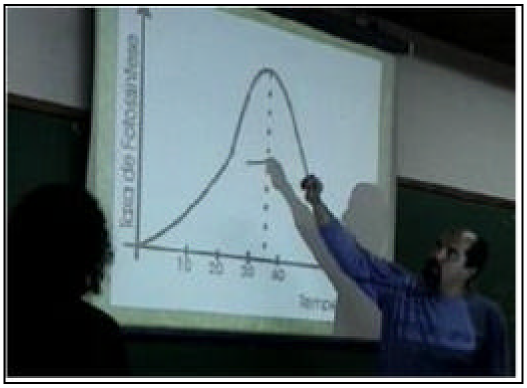
In a more artistic fashion, the parallel lines poem, *http://publish.edu.uwo.ca/george.gadanidis/parallel/*, proposes ideas that challenge the predominance of Euclidean geometry in our way of seeing parallel lines. Ideas like this materialized in the virtual world can also, as proposed by Boal, blur the difference between the spectators and actors. Theater and cinema have conditioned different kinds of spectators, and now the Internet may be creating what Boal had dreamed of: an active "spectactor". Theater allows two-way interaction in a way that cinema does not. In the first case, actors can tease the audience or even invite some of them into short parts of the play. In theater, each person has a standpoint, seeing the stage from a different perspective. In cinema, it is hard to think about teasing in the same way possible in theater, and although the seats in the theater are different, we all see the big screen in the same way. This does not mean that cinema is worse than theater or vice versa, but that the way we structure the means of communication, the medium, opens and closes possibilities.

The ideas of Boal and Kress, respectively, about blurring audience-actors and about multimodal language, are consistent with the notion of humans-with-media. Different collectives generate different kinds of knowledge and transform the very notion of problem. As the Internet enters such collectives, we can say it brings its new interfaces which, for instance, allow for multi-modal language. In the virtual world, the role of actors and audience is also being blurred, with the collective creation of homepages, and increasing accessibility of processes to produce material for the virtual world. Thus, I believe that digital mathematical performance, or digital performance, may be an alternative to what is practiced in schools that do not bar the Internet from teaching and learning (Gadanidis, 2006). Maybe generating performance, in the sense of performance arts, will be the goal of a school, in contrast to the views of some schools that are just concerned with performance in the radically different sense of measuring students' and teachers' achievement through some mathematical rule.

Modeling and digital mathematical performance can, therefore, represent alternatives for "problems" for students to deal with once the Internet becomes ubiquitous in our schools. But again, the different roles that students and teachers play, and the very notion of multimodal language, despite being more relevant to environments in which Internet is a major player, are not limited to such environments. Reflecting on the way the Internet may transform the classroom helped me to think about how other types of interfaces played different roles in other types of classrooms. For instance, geometry software also transformed the problems posed in the classroom. Like function software, they invite students to experiment, value the activity of trial and error, and at the same time, according to some (Laborde, 1998), allow demonstrations to be enriched by analysis of particular cases. In this sense, collectives of humans-with-geometry-software provide the students with the experience of experimentation without overriding traditional roles of paper and pencil, such as the one played in demonstration. There are classrooms in which both media co-exist, in what can be seen as one more case of Levy's (1993) idea that one media generally does not replace the one it competes with, but rather incorporates it, and I would add, transforms it.

But the use of software in the classroom also changes the status of visualization in the classroom. The "flashier", more dynamic and interactive process of drawing graphs of functions and different geometric figures is becoming a more and more present language in the classroom. This language is, of course, multimodal. The dynamic of figures was connecting the world of school, traditionally associated with writing, to the experience most were already having with television, and that many others are starting to have with the Internet, as well. Experimentation and visualization has invited body language, in particular gestures, to play an important role in mathematics education (Arzarello & Robutti, 2004; Borba & Scheffer, 2004). Like our arguments regarding the Internet, we can say that this software has already initiated the creation of a multimedia language, or in Kress' (2003) words, a multimodal language.

Internet, software paper and pencil and orality are not only media that express ideas, they also shape ideas and language. It is in this way that I see them as actors in the collective of humans-with-media. Graphing and geometry software brought the first generation of multimodal language into mathematics, and I believe that approaches like modeling have been paving the way, prior to the arrival of Internet, for transforming the belief that students' activities should be limited to solving problems into one in which they also participate in the design and development of projects. A look at the following pictures can show static views of students working with a graphing calculator, discussing graphs on the blackboard, pointing and performing other kinds of gestures, using PowerPoint to present part of their project, the teacher pointing, explaining and debating with students.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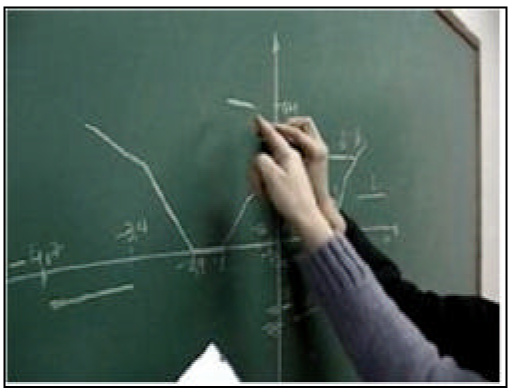
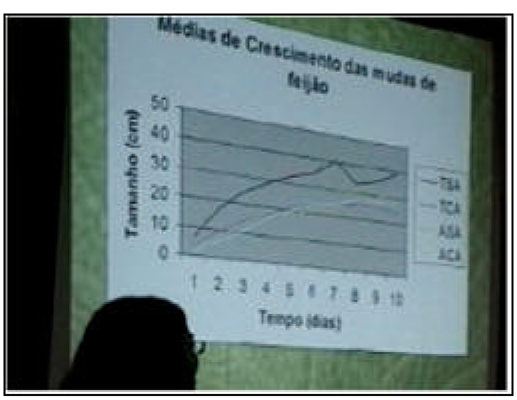
10 20 30 40






Médias de Crescimento das mudas de feijão
Tamanho (cm)
50
40
30
20
10
0
1 2 3 4 5 6 7 8 9 10
Tempo (dias)
TSA
TCA
ASA
ACA


All the above pictures came from a mathematics class for first year Biology majors in which students experience the use of graphing calculator and modeling, together with more traditional use of the blackboard and solution of exercises in the classroom. If we look with performance eyes, in the way that Gadanidis & Borba (in progress) are attempting to develop, it can be seen that, in the face-to-face classroom, the possibility exists for actor (teacher) and audience (students) to play out some versions of Boal's theater of the oppressed, in which actors and spectators change roles and are transformed into spect*actors*.

CLOSING REMARKS

In this presentation I intended to express some ideas regarding what I believe to be a synergy between digital mathematical performance, modeling and the increasing presence of Internet in educational environments and elsewhere. Modeling and digital mathematical performance may be two options for the mathematics classroom in which the Internet is welcome. Internet actually enlarges the possibilities of modeling, as it allows for the realm of themes that students can choose, as discussed in Borba & Villarreal (2005) and Malheiros (2004). Internet and user-friendly browsers are inherent parts of digital mathematical performance. We believe that as access to Internet increases, and user-friendly tools become more available, possibility of collaboration and constant change in pieces of digital mathematical performance may become even more real. Modeling and digital mathematical performance are in the process of becoming not only alternatives for face-to-face classroom, but also for online classes. In the latter, the attempt to prohibit Internet from entering the classes is almost impossible, but that is a subject for another paper.

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