TRANSACTIONAL DISTANCE AND COMPUTER AIDED TEACHING OF GEOMETRY: IS IT PRESENT IN PRIMARY SCHOOLS? ORDINARY CLASSROOM?

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In this paper, difficulties of students in the case of computer-mediated teaching of geometry in a traditional classroom are considered within the framework of the "transactional distance", a concept well known in distance education. The main intent of this paper is to record and describe in detail the different forms of this distance during students' efforts to cope with tasks concerning the calculation of the area of several regular shapes.

INTRODUCTION

It has been stated by Moore, describing the universe of teacher-learner relationships, that "distance education is not simply a geographic separation of learners and teachers, but, more important, a pedagogical concept" (Moore, 1997). More precisely, transactional distance can be described as the psychological, conceptual and communicational space between them. This transactional distance could be met in any educational programme, even in face-to-face education and its extent depends on three variables: the dialogue, the structure of the course and the learner's autonomy. The "dialogue" has positive qualities that other interactions might not have. A major component of the dialogue is the nature of medium of communication. In the case of computer aided teaching of geometry in a traditional classroom, personal computers permit an intensive, individual and dynamic transaction. In some cases, computers and networks allow an increased teacher-learner and learner-learner interaction, which can influence transactional distance in the classroom (Venkites, 2001) or even more can partially bridge the transactional distance. But in other cases, such as we describe above, computers, in some way, increase the transactional distance.

Moore initially made a distinction between three types of interaction: learner-content interaction, learner-instructor interaction, and learner-learner interaction (Moore, 1999). Later, Hillman, Willis and Guassendietta added a fourth component to the model, the learner-interface interaction. They claim that the interaction between the learner and the technology that delivers instruction is a very important component of the model (Hillman et al., 1994). Learners who do not have the basic skills required to use the interface of a communication medium spend excessive amounts of time learning to interact with the technology in order to be able to learn the lesson. (Guassendietta & McIsaac, 2003). Interface is an intermediary space between the user and the so-called educational material and it constitutes an important component of the educational milieu. When scientific knowledge is divided to an educational milieu it undergoes a series of transformations. So, interface must be
considered as a system, which comes in between this transformed knowledge and the student. This role of the interface results in a transitional distance between students’ conceptions and the way in an educational software functions. So, in this paper we present our findings concerning some cases of transitional distance, which occurs when students are dealing with conceptions of geometry with the support of computer.

DESCRIPTION OF THE STUDY

The study included tasks concerned with the area of the regular shapes in a computer-based environment (see Appendix A). Five groups of students participated. It was about students of the 5th and 6th grade of primary school as an urban area of Greece. They had already been taught the concept of area and the formulas for the calculation of the area of known shapes (triangles, squares, trapeziums etc.). The tasks were non-standard. The reason was that we wanted to avoid the simple repetition of known mechanisms for the estimation of area. Moreover, we did not require a lot of formal knowledge of geometry and at the time they are liable to dynamic approach in a computational environment (Koschermitz and Hoyles, 2005; Ingold, 1999).

We used three different applications: GeoGebra, GeoComputer and MISPrint. Depending on the tasks the students had to cope with, either they used only one of the software, or a combination of them. The researchers chose the software and not the students. Students had the chance to be familiar with the capabilities of each software during the training period prior to the main research. We also used the Camtasia Studio suite so as to record the activities and choices of students in the computer screen (as .avi files), a video recorder to record the groups while they were working in the laboratory’s environment and a tape recorder for the interviews taken after the completion of the tasks.

RESEARCH FINDINGS

These cases of transitional distance were observed during the performance of the specific tasks. We do not consider all these cases of transitional distance as equivalent and we propose a categorization of them, based on their origin.

1. Distance between what the students usually do and the way the software functions.

This kind of distance is connected usually with technical issues. It is known for example that formulas in geometry are two-dimensional while keyboard usually functions in a linear manner. This second manner of expression of the formulas is much more complicated and less functional than the first one, since it needs more parentheses and makes less obvious the arithmetic operations which have to be done. Students in the study needed in a task to calculate the area of a trapezium. They used the “Calculate” tool of Cabri but they typed the formula without considering the
priority of arithmetic operations. So, since they knew that the formula was \( E = \frac{V}{V + S} \), they typed in the window of the "Calculation" tool \( E = \frac{1}{1 + 2} \) (see Figure 1). The result was that their estimation was different from that of the "Area" tool.

In the same context, we observed an error due to the way decimals numbers are represented. In Greece, the formal way to write the decimal point is by using the "comma" and not the full stop. So the students met the problem that despite they were given the correct order to the "Calculation" tool for a specific operation, the result was always an error message (see Figure 2). In this case, the system did not have the required capability to conserve student's orders and it simply considered them as an erroneous formula.

2. Distance because of the different meaning of the same word in relation with the context.

It is not always certain that what the student "says" is conveyed by the interface in a way that preserves the same meaning. In this occasion, the transactional distance occurred when the students found in the menu tool-bar of the software words familiar to them through their daily life. So they tried to use them based on their common meaning and not on their mathematical use on which the designer of the software
3. Distance because software’s inability to correspond. Many times there is a distance between what the students want to do and what the software can offer to them. There are restrictions on the software’s capabilities and consequently a limitation on students’ actions. This is why what they initially conceived as the right strategy was some things impossible to be applied on the computer screen (Pappadopoulo, 2004). Additionally, there is a distance between what the teacher has in mind to do and how software can support her/him. The fact is that behind the software exists the person who designed it and he did not have in mind the particular student or the particular situation in which the teacher would decide to use it. Students find on their computer screen just a part of the corresponding knowledge because a software rarely covers the entirety of a mathematical concept (Ungurea & Pappadopoulo, 2004). In the second task, students worked with MSPaint. They tried to transform the not-regular shape to a new familiar one preserving its area through the actions of “cut”, “paste” and “rotate”. The restriction was that they had the possibility to rotate pieces of the initial shape only 90°, 180° or 270° clockwise, despite the fact that in some cases they wanted to realize a rotation of a number of degrees different from the above.
mentioned numbers (e.g. 45°) (see Figure 4). From the viewpoint of the teacher now, there were distance because some desirable uses of the computer became unattainable. Such uses were: a grid that could easily change the shape of its units, enlargement of certain regions to facilitate some divisions, a tool of automatic measurement of whole square units that exist in a not regular shape etc.

Figure 4. Rotation in MS Paint.

4. Distance in conceptualization.

This distance has its origin to the fact that the concept that is to be taught is usually mediated. In the modern educational software interface allows the management of microworlds, which represent or simulate a system. So, whereas the user has the feeling that he handles directly a microworld, he actually handles indirectly a particular materialization of the simulation of a system. Students have in front of them objects (computer diagrams) whose behavior requires interpretation by the students. More specifically, the students had at first glance to cope with the same basic shapes in all the three environments (segments, triangles, rectangles, squares, ...impulses). These shapes had exactly the same appearance but actually they had completely different properties and behavior. Any representation of them in each of the three environments emphasizes some aspects while hiding or giving weaker role to others (Stiehlebrand, Latorre and Sterner, in press). These basic shapes presented to the students are mediated in the following manner:

1. Cobri. Shapes in Cobri have a dynamic behavior. When an element of a diagram is dragged with the mouse, the diagram is modified while all the geometric relations used in its construction are preserved (see figure 5).

2. MS Paint. Shapes in MSPaint behave in a different manner. Students can select any part of the shape. They can cut this part, move it in any new position, rotate it, color it, etc. (see figure 6).

3. GeoComputer. Shapes in GeoComputer are consisted just of segment lines that are connected to their edges. These shapes are not bearers of the certain properties, which accompany them by definition (see figure 5).
The consequences of this distance were apparent during students' efforts as they tried to transport and apply knowledge from one environment to the others. For example, they tried to select parts of the shape in Cubi and then to rotate them in a manner similar to one of the MSPaint. In the same way they tried to segment one side of the shape so much as Cubi as well as in MSPaint in a manner similar to that of GeoGebra.

5. Distance in the level of knowledge.

This final distance is an extension of the previous one. The distance in conceptualisation results in distance in the level of knowledge. The description of the nature of this distance is as follows: There is the knowledge that is acquired through the multiplies and repetitive usage of a certain software. This usage shapes progressively an internal knowledge related to a partial meaning of a certain concept - we could name this knowledge as a "procedural" one. On the other hand, there is the formal knowledge as it is described through the official curricula – we could name this knowledge as a "declarative" one. These two levels of knowledge do not usually coincide, leading thus to the above mentioned distance.

CONCLUSIONS

The term "transactional distance" is used broadly in distance education but as Moore states, it is more about a pedagogical distance. In our case this distance is expressed in a difference between two interrelated levels:

Level 1: Difference between the intention of the user and the way the software functions (such as it is considered part of the operational distance). The student or the teacher intends to realize a certain construction, or a calculation or a transformation, but the way the software functions either doesn't permit their realization at all, or in some cases it allows a realization but in a way that is unusual and consequently incomprehensible to the student in a great extent. The categories 1 and 2 belong to this level.

Level 2: Students and computational system with very different meaning in activities and random. Changes on the computer screen (e.g. changes in figures, the shape of
Some of the transactional distance cases could be overridden in the technical level—like the difference between 'oma' and 'full stop', or the two-dimensional nature of mathematical formulas (which is already available in other environments as a word processor). But some others seem especially complicated.

Furthermore, some of these are due to the nature of the educational milieu. The informational system has jarring boundaries, for example finite sets of numbers, and in some cases this could affect the transactional distance. But in other cases this distance is almost independent of the informational system, e.g. the students' conceptions about mathematical concepts that are involved in the solution of a problem. All the above-explained cases are also present in the traditional classrooms but usually they pass unnoticed or teachers handle them in the context of the didactical contract.

Transactional distance seems to form an efficient tool for the study of specific didactical cases in real computer-aided teaching. Besides our data suggest that possibly this distance functions not merely as an obstacle for the learning but even more as a source of new didactical obstacles e.g. the wrong conceptions of the students. In this case the conditions of the usage of educational software need to be examined closely. It constitutes one of our future research targets.

REFERENCES


Appendix

Task 1. Estimate the area of the shape. Is it helpful to transform this shape into a new, easier shape to know, so as to estimate its area? Why? Why not?

Task 2. Calculate the area of the shape.