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COMPARING RESULTS OF TEACHING MATHEMATICAL CONCEPTS BY USING COMPUTERS IN MULTIMEDIA AND NON-MULTIMEDIA ENVIRONMENTS

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1. INTRODUCTION

The proposal by S.Parert (1980) regarding the creation of a *mathland* based on computers, through of which, the education can reduce the difficulties of teaching maths, is a challenge for the education. Through of this challenge, the education will find out certain methods of reducing the difficulties of teaching the maths and therefore will provide to children the feeling of *like-to-learn* against to *learno-Phobia*. The above challenge such as other different point of views concerning the introduction of computers in schools, like:

- The computer have the power to change the way that children learn maths (Rogalski 1988)

- The computer changes the mathematical activity and can be considered as a way of teaching and a help for teachers both (Cornu, 1978)

motivated us to organise a way of teaching mathematical concepts using computers. Specifically, we organized the teaching of the Greatest Common Divisor (GCD) first with traditional computer technologies (raster graphics provided by programming languages, like Pascal) and secondly with multimedia authoring tools.

Relatively with the construction of educational programms with traditional computer technologies, we discovered that its certain principles are still behaviouristics (*instructional material*, Stolurov, 1969) and a student must (is obliged to) learn it. Namely, the creator of the program (which can also be the teacher) has his own idea of what the student expects to learn and the program's structure is influenced by this personal view. In this case the students opinions, misunderstandings and alternative interpretations are recorded as *errors* (behaviour different from the expected one, *principle of behaviourism*).

One of the most interesting features that multimedia provides is the great interactivity with their users (in our case students). This capability, allows the student to become the *leading actor* of the learning procedure. So, with the motive and the spontaneous action, the knowledgable shapes are strengthened and results in easier and quicker learning *(child centered)*.

2. THE EXPERIMENT

In our experiment we compared traditional computer technologies and multimedia based on two similar games. The first game was implemented with traditional computer technologies and the second one implemented with multimedia authoring tools (ToolBook).

Our purpose was to teach the Greatest Common Divisor and we did it in the shape of game. In both games, a rabbit is in front of three carrots planted in a zig-zag line and in a distance of 14 meters between the first and the second and 35 meters between the second and the third carrot. The rabbit in order to eat the carots does steps greater than one meter and less than 14 meters. The carots are eaten only if the rabbit's steps coincide with the planted carrots.

The games were presented to couples of children. Our effort were mainly focused in the reactions of children facing the mathematical concept with the new teaching methods. We have also observed the effectiveness of the traditional computer technology approach and the multimedia approach.

3. METHODOLOGY

In our experiment the students are in a direct influence with the computer while the teacher (the researcher in our case) has the role of the observer ready to intervene if it's necessary.

In both games, we followed the research method of Didactic problems that was first implemented in France by Balacheff, Laborde and Brousseau and that is based on clinical observation. Namely, we presented both games to couples of students whose dialogues were recorded. Subsequently, we made a qualitative analysis of the dialogues between the students. This analysis revealed the students' opinions, the sensible procedures of learning and also the sensible strategies which were followed during the games' progress.

4. ABOUT THE GAMES

Both games attract the students' interest since there is interaction with the computer. The first game uses coded pictures (a square for the moving rabbit and a spot for the carots). However, there are stative pictures, a rabbit and a carot in a corner of the screen, that reveals the assosiation of the rabbit with the square and the carot with the spot. One point that must be made clear is that the first game doesn't offer the opportunity to the students to backtrack to a previous point of the game. Therefore the first game is characterised by reduced interactivity. The second game uses scanned cartoons, instead of coded pictures. This game also offers a freedom to the user (student in this case) to interact and bactrack to any previous point of the game's progress. This is an inherent feature (*interactivity*) of multimedia creations that is proven more usefull in teaching enviroments

5. THE EXPERIMENTS ACCOMPLISHMENT

The first game was presented on May, 1988 to five couples of students. Two couples were composed from students of the upper level, two couples of the medium level and the last couple were composed from students under the average. These presentations took place in two high schools of Athens with students fourteen years old.

The second game was presented on June, 1994 to five couples ranging from the mid classes of primary school (from 10 years old) to the first class of high school (13 years old). These presentations took place in a small town called *Kamena Vourla*.

6. PROGRAMM'S STRUCTURE

The didactic strategy that was followed in the first game was based on Crowder's *branching programs*, where there is the opportunity for the student to choose one of the available answers. The program evaluates the answers and in case of wrong answer reminds previous knowledgment. This help the student to choose the right answer at a second chance. In case that the second answer is also wrong, the right answer is appeared on the screen with the appropriate explanation. In case of right answer the program rewards the student and displays (on the screen) this answer, in order to increase the understanding of the provided concept with the help of optical perception.

6.1 The game in traditional computing environments

We made a programm whose content is a *pneumatic game* in the shape of *question-answer* between the student and the hero of the programm (the rabbit). The hero asks for advise the user of the program (the student), every time it has a dilema.

According to D. Lacombe (1983, 1984) there are two kinds of questions that a teacher can ask in the classroom:

- The questions that not even the teacher knows the answers and are called *real questions*

- The questions that their answers are known to the teacher and are asked to the student during the lesson time (we call them *inductive questions*).

The questions asked by our program belong to the second kind of questions. However, these questions are considered as *real questions* by the children. This happens, since the questions are asked by a little small animal (the rabbit) and the child psychologically neither feel that is examined nor feels inferior in relation with the teacher. So, this game of *question-answer* is a pleasure for the child.

The basic picture of the program has a zigzag line where three carots are planted and a rabbit which is the hero of the game. To be more precise the carots are represented (coded) with spots and the rabbit is represented with a square. These assosiations are obvious since the original shapes of rabbit and carot are present in the upper side of the screen along with the square and the spot. The basic animation in this scene is the movement of the square towards the spot. When the step used in the movement is a *common divisor* of the distances between the first and second spot (carot) and the second and third carot, the square surrounds, at subsequent stages, all spots. In other words when the student selects a *common divisor* the rabbit eat every carot.

Our decision to make a not difficult program but to present the mathematical concept of GCD in the shape of game, is based to the following reasons:

- It is known that all the children of any age are attracted by the computer, especially when is used for playing video games.

- The Platon's incitement to the teachers of ancient Greece "Μή βία ώ άριστε, αλλά παίζω τους παίδας τρέφε".

- The point of view of Frowebel, Montessori, Decruly, Dewey, Cousinet, Schleiermacher and Cross that the game plays a forcing role to the student since the child with a pleasant way can familiarize a great amount of knowledge (Giannoulis, 1980).

- Psychologist A. Antler believes that the game must not be regarded as an unusual inspiration of parents or other teachers but as a help for breeding, as a stimulating of mind, fantasy and adroitness.

6.2 The game in multimedia computing environments

The design of the second game was based on the same script. However in this case the implementations were easier, since the multimedia authoring tools offer features that are heavy to be implemented in traditional computing environments. Thus, the author of the program spend most of his time to make the game more attractive, instead of writing boring loops, etc.

The created multimedia game uses scanned cartoons instead of coded symbols (a square and a spot in the non-multimedia game). Thus, the second game present real animations to the user of it.

The most interesting feature of the multimedia creation is the opportunity for backtracking that is offered to the user. The users of it can shift from one page to a previous or next one by clicking the available buttons. This ability, offer to the student the opportunity to read again the problem's facts and limitations and also to enjoy himself by watching the rabbit's movements. We believe that this feature of great interactivity (offered by multimedia creations) can help to the construction of shelf teaching games.

7. ANALYSIS OF THE RESULTS OF THE EXPERIMENT

The analysis of the dialogues among binaries during the lesson *(problem game)* was done with the following thoughts. We distinguished:

- Visible characteristics: such as successive, influence, colloboration, observer's influence (social parameters), behaviour, etc.

- Non visible characteristics: such as mental procedures and steps for the problem's solution.

The decoding has done with the help of recorded dialogues and questions which were asked by the observer, sometimes successfull and some others not.

7.1 Level of visual characteristics

Both in the first and the scond experiment, the way we worked (couples of children with an observer), was a new experience for the most of the children. Because of this, in the begining of game playing, most children expressed a hesitation and they were afraid to discuss. However, this hesitation were overcomed as soon as the observer gave some explanations to the children.

Children with a bit of experience, were adapted easily to the computer environment. The rest of them, with a little help in the beginning, were also adapted and finally cooperated with enthusiasm.

Most students (mainly those in higher level) discussed and decided together during the game playing and behaved with respect to each other. Only two students (one in a low level and the other in an average level) tryied to impose their attitude, even when they weren't sure for the solution they proposed. Some children in the begining, argued about, because they couldn't decide who will be using the keyboard (in the first game) and who will be using the mouse (in the second game). Finaly, all these problems passed away quickly and a very good cooperation was established among them. The children were also asking the observer for help without any hesitation for any technical problem or for further explanations concerning the experiment.

All the children spontaneously personificated the rabbit and they were talking to it using this kind of expressions:

"What are you saying now ?"

"Oh, I can't understand you."

"I'm gonna show you, if I've made a mistake."

All these expressions, especially took place in the second game when the rabbit wasn't just a static draw, but a cartoon.

In general, the environment was very pleasant, the children were having fun and they never thought even for a minute that they were in a *learning-state* condition.

7.2 Level of Non Visual Characteristics

In the first experiment, when they were close to the solution of the problem, we found out that a lot of children (3 out of 5 groups), they returned to the beginning of the problem (by quiting the program and start the program from the beginning), for a more intensive reading of the problems facts and limitations (feedback).

Also we observed random actions (from the low level students) and inventing actions (from the most groups). We came across in some *Knowledge-strategic* characteristics mostly in the high level student groups.

In the second experiment we observed constractive feedback, due to the program's facility to backtrack from one page to another and reading again the problem's facts and limitations or viewing the rabbits indications.

The actions of the students in the fourty grade of the primary school, were very interesting. The reason for that was that we found out *Knowledge-strategic* characteristics. As Brumer said the ability of the student to direct his memory, attention, and mind, which was developed through the use of the program.

Actually the ability of bringing as often as the student wants the first program screen, where the distances between the carrots are shown, helped the student to find the correct jump (length 7) because the length of the first distance (14 rabbit-metres=2x7) gave them the first idea. This ability, available only in the second game (program), arises from an inherent feature of multimedia, the great interactivity.

We observed prescient actions concerning the "Jump 7". We also observed mental-testing actions sometimes only for the first distance (14 rabbit-metres) and sometimes for both the distances (14 and 35 rabbit-metres). This means that we had a prescient approach of the common divisor.

We also came across of some *random* actions who finally lead the students to understand he consept G.C.D.

We also want to make a comment on the participation of a yound student aged 81/2 years. The student was finding the correct jumps by playing and by practicing his abilities in the multiplication. The student also showed enthusiasm when he was finding the correct jumps but unfortunately we didn't spend a lot of time with him due the lack of time. The most significant was that the young student was happy because he was helping the rabbit to eat the carrots.

8. CONCLUSIONS

In the first program the role of the computer *as a tool* exceeds the role *as a teacher* because the screen becomes the main factor for the games consignment, but for a furthermore understanding the presence of the teacher is necessary.

But although the role of the teacher is not so important, and not so obvious, it is effective once's he had the achievement of our goal.

In the second experiment the results were extremely good because a) we were focused in the process of solving mental processes based on inventing and the knowledge strategic (even when we were reminding the G.C.D. to older students even when we were teaching the concept of the G.C.D. to children in the fourth grade in the primary schools. b) We achieved the understanding and the conquest of a concept (G.C.D.) by children in contrast of the children's age that the analytical education programs suggests that this concept should be taught.

Comparing the results of these two programs we notice that the second program is much better than the first one due the effective which arises through the optimization of the educational principals in contrast with the first program.

These characteristics are the attractiveness, liveness and closeness. Those characteristics were remarkably supported-through the use of multimedia.

One of the first program's principal is the wide use of natural language (in a mathematical problem) and the minimum use of mathematical relations (mean average in the use of the mathematical language). This feature contributed to its effectiveness. In the second problem there aren't any mathematical relations (children's fright) and the only mathematical language element is the definition of the G.C.D.

So the program creates a pleasant environment for the student who get interest in it.

Moreover Laborde (1982) and Pimm (1989) studies prove that the use of natural language provides students with ease in understanding a mathematical ratio.

Also the visualization (Bishop, 1990) partly in the first program and totally in the second program (through the use of multimedia) of the steps of the division algorithm (distance between the carrots) contributed to the understanding of the G.C.D.

That is why the program with the use of multimedia could offer an important help in a self-teaching situation. [The computer acts as the teacher]. (After the editing of a screen to which mostly the young children stucked, they leave after 3 or 4 attemps, but this is not a very serious disadvantage).

Also its contribute to easy and pleasant understanding is significant if we follow this method:

> The teacher presents the programe to the class using a screen projector and then each student by himself in propotion to his abilities, studies playing with the program, so that he understands the concept he was taught.

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