

Modelling activities with educational software with regard to computer's operation

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Abstract. *In this work we present the design and the evaluation of a set of educational scenarios with the use of the modelling educational software «ModelsCreator». The scenarios in question are related with the learning of basic significances of computers' technology in the secondary education. This work aims to contribute in the study of growth and of use of model instructive material based on open educational software on the ground of didactics of Sciences and more specifically on didactics of Informatics.*

Keywords. Didactics of Sciences, teaching computers' hardware, modelling software, instructive scenario, instructive intervention

1. Introduction

Nowadays Informatics constitutes a basic course in the Greek secondary education while the problems that her teaching places have not been yet studied sufficiently in the frame of Didactics of Sciences. Didactics of Informatics, as a proper sector of Didactics of Sciences mainly has dealt with the instructive subjects that concern programming. In reverse, in the classroom or in the computer lab, learning and teaching of personal computer's hardware constitutes an exigent and complex cognitive subject [7] that very little has been studied. The concepts that concern this thematic area are not always immediately and optically remarkable by the students and the teacher. In the same time, parameters that affect in personal computer's performance (as an intergraded system of hardware and software) are several and complex. So, in the frame of school, easy and effective implementation of experiments with real software and computer devices is not possible.

In the frame of this questioning we designed and implemented educational material with use of computer modelling environment gunning for

the learning of computer's operation. The expediency of using computer modelling environments in educational process has been explained sufficiently by modern pedagogic research [3], [5]. At the same time, Computer Science uses models in order to study real or hypothetical phenomena and manufactures [3].

In the first part of this work we study a complete instructive scenario that concerns in the thematic unit of internal structure, organisation and operation of personal computer as intergraded system of software and hardware. In the second part of work we analyze an instructive intervention that became in a real classroom situation with the use of scenario in question and we study the instructive problems that resulted from this application.

2. "ModelsCreator" software and instructive scenarios of Informatics

2.1. "ModelsCreator" software

"ModelsCreator" (MC) is a computer-modelling environment that permits students to create and test models representing different aspects and phenomena of natural world. The models' behaviour test takes place by direct manipulation and multiple representations (simulation, bar charts, graphs, tables, etc.) [8]. "ModelsCreator" contains objects that have a mediating role helping students in mental manipulation of abstract entities and concepts (properties of objects). Properties of the same entity or other entities can be connected with qualitative, semi-quantitative or quantitative relations (figure 1). "ModelsCreator" integrates semi-quantitative models, quantitative models, and executable decision making models as well as static qualitative models (concept maps), with special emphasis on semi-quantitative modelling. These models meet the requirements of many curriculum subject matters, permitting

interdisciplinary use of the modelling process.

2.2. Case of instructive scenario of Informatics with “ModelsCreator”

Aim of instructive scenario of Informatics with “ModelsCreator” software is the creation of an alternative instructive approach against the schoolbook-based approach. This alternative approach concerns in the modelling of an intergraded computer system, using its distinct units, and in the study of this system’s behaviour from the user’s point of view, under various real situations. Thus a more "authentic" [1] learning environment of the specific matter of study is created.

In the framework of the scenario in question students are asked to create a personal computer’s model, by selecting relations between the various properties of processor, of RAM memory, of hard disk, of graphics’ card and of computer system’s speed. After having created a personal computer’s model, they try it with various applications. They count the time of application’s commands execution and observe the general model’s behaviour. Thus, they evaluate the relations that themselves have selected. We use four types of applications (Desktop applications, Image Editing Tools, Multimedia applications, 3D Games), for which we simulate the count of their execution time under various hardware systems.

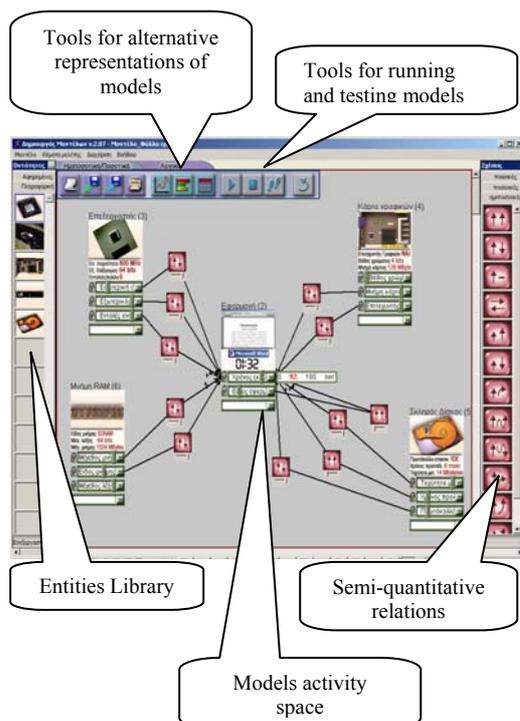


Figure 1. “ModelsCreator” interface

For the specific’s instructive scenario needs, “ModelsCreator” interface (Figure 1) includes an entities’ library, which contains 5 entities and more specifically: Processor, RAM Memory, Hard disk, Graphics’ card and Application. Certain properties can be attributed to these entities. The modelling activities that we propose in the particular thematic unit are approached, in the framework of instructive transformation of scientific knowledge [9], with the help of semi-quantitative reasoning:

A. Relation “when the one is increased then the other is decreased”:

«As long as the size of internal’s frequency operation of processor’s core is increased, so much the time of application’s commands execution is decreased » [13]

B. Relation “when the one is increased then the other is increased”:

«As long as the access time of hard disk is increased so much also the time of application’s commands execution is increased » [13]

Γ. Relation “changes in the one do not influence the other”:

«The changes in the word’s size in memory RAM do not influence the time of application’s commands execution » [13]

In every case of relation between entity’s attribute and time of application’s commands execution, we consider that the other parameters that also influence the execution time remain constants.

Model’s creation procedure presupposes entities’ determination, entities’ properties determination and relations between properties determination as well, in the workspace of the environment. The trial or the execution of the model becomes or manually, or automatically, or step by step, using the execution’s model tools. The environment also permits the user to observe simultaneously the simulation of model’s real situation (optical representation) and the model’s evolution via an alternative representation (bar charts, graphs, tables).

In the environment of “ModelsCreator” the modelling and trial activities concerning a personal computer can bring up students’ alternative perceptions with regard to personal computer’s structure, organisation and function as an intergraded system of software and hardware. Thus, it is possible that the activities in question can constitute the frame in which the instructor will attempt facilitate the construction of corresponding scientific perceptions by the students.

3. Study of instructive scenario in conditions of real computer lab

In this section we will shortly analyze a case study with the use of instructive scenario that was developed previously. The case study took place in conditions of real computer lab. The all activity is included in an instructive effort of instructive objectives achievement of "Computer's hardware" course curriculum in the framework of initial professional education.

Three workgroups of students participated. The two workgroups were consisted of two students and the third one was consisted of three students. All the students were coming from the Information Technology and Networks section of a Technical Professional School. Instructor during the activities was one of the researchers.

The instructive-training activity with each workgroup kept about 50 up to 60 minutes. Each workgroup was separately informed about the environment and it used the ModelsCreator's tools before the instructive-training activity. This process kept roughly 10 with 15 minutes. The common instructive-training activity-intervention was recorded. Digital camera recorded the non-verbal communication of the students; however the computer screen was not recorded. During the activity, only the workgroups of students and the instructor were in the computer lab.

As resulted from the total educational dialogue analysis, the training activity total followed the structure Initiation – Response - teacher-led discussion – Initiation - Response (IRtIDIR). We consider that this structure was initially and fundamentally shaped by the "open" type educational environment we used, as well as from the objectives that we had placed for the activity in question. The environment is characterized as "open" with the significance that it has the role to convert the students' proposals and not to guide them by prompting or making indications. That "open" educational modelling environment created a context in which the element "Follow-up" of the communication structure (Initiation-Response-Follow-up) [6] breaks down as "teacher-led discussion" and new informed "Initiation" and "Response". Thus, when we refer to the "activity of model's construction and execution" we talking about the educational dialogue that took place during the students' and teacher's initiatives with regard to model's construction and execution (Initiation) and to transformation of these initiatives (Response) from itself the educational

environment through user interface's exterior representations and simulations. We are not talking about the discussion which was guided and supported by the teacher (tID), in which the environment tools and representations were not finally used and which followed the first (IR) phase and preceded the final (IR) phase.

In the first (IR) phase students expose their collective option concerning the cognitive object by selecting relations between the processor's properties and his performance. The model's execution with instructor's initiative does not ground the educational workgroup's dialogue. Only that it accomplishes is student's appropriation of the symbol's system used by the educational environment. For example, it accomplishes in order that the students associate the significance of "reverse proportion", with a simulation that uses alternative representations: numerical values' fluctuation, bars' fluctuation or entities exterior representations' change (optical representation). The entities exterior representation's change however was not associated with the real phenomenon of upgrade and test of a computer system performance, at least not for all the students.

In episode 1, during the model's construction and execution, student A shows that she has appropriated the symbol "increase-increase". Student A, as well as the student S, they try to ground their choice concerning the relations by asking either their schoolmates or the instructor; in no case however they do not try to achieve grounding coming from the user's interface simulation and representations. The instructor refers in grounding that will be carried out later (in the phase of tID) or he calls them to decide based on their collective experience and knowledge. It is obvious that this call does not bring result as is not produced any type of creative discussion.

3.1 Episode 1: Appropriation of the symbols' system – Initiatives for grounding

(We mention a dialogue which took place during the students' effort to accomplish a relation between "processor's internal frequency" and "application's execution time" using the chart tool, as well as part of dialogue for the choice of remainder two relations between "exterior data bus width", "commands per circle", and "application's execution time")

Instructor: Let's see again. We can see it also with a chart. That means we can put a chart right here. And after that I can put this property and that one also and then I press the OK button./ Let's see now how it works. /Now it played fast, very fast, agree? / Let's put it step by step./ As long as

the internal frequency is increased, so much also the application execution time is increased all right? This property you have selected therefore put and the other properties put and the other relations.

Student A: Is this correct?

Instructor: I don't know, you work on it.

Student F: Put the external bus.

Student S: How we can know if it is correct?

Student F: Put the external bus.

Student S: This one, we take it off?

Student F: Also the execution time.

Instructor: No, you don't take it off, you put it in parallel.

Student A: What we have to put here? (Students F and A talk each other) What it match with? External bus and execution time are increased both (she shows two up arrows with her hands). The external bus and execution time, the one goes up, what? Me, I can't.

Instructor: Do you understand what this relation means? If you put this relation that means as long as the internal frequency is increased, so much also the execution time is increased

Student F: Yes

Instructor: If you put this relation that means as long as the internal frequency is increased, so much also the execution time is decreased. You just put a relation here. Do you want to put also a relation up there? Put the relation and we see it again later

Student S: Yes, but this is correct now?

Instructor: I don't know. Put also the rest of the relations and we see it again later.

(Is interfered dialogue that concerns choice of relations which is not mentioned)

Student A: Which one is the correct?

Student F: This one.

Instructor: Before put it, think about what happens in real world

Student S: Yes, the processor...

Student A: Me, I don't know

Instructor: Put any relation and we will see it later.

After model's construction by the students it follows a scaffolding process (tID) between the instructor and them, which focus in the questions of the worksheet. In this phase the grounding does not emanate from the previous (IR) phase, as someone would expect, but it constitutes a supporting activity of common knowledge construction between the instructor and the students that is grounded only by this common knowledge. In this phase, environment's tools and representations are not used.

In episode 2 the educational workgroup tries to construct mutual understanding to answer the question of worksheet that concerns the relation of internal frequency of processor's core with the number of clock's circles that times the processor.

3.2 Episode 2: Internal frequency and number of clock's circles (Workgroup T-Z)

Student T: "When the processor's internal frequency is 800 MHz that means the internal clock..."

Instructor: "Per second, what does it do per second?"

Student Z: "Read it again"

Student T: «When the processor's internal frequency is..»

Student Z: "Yes.."

Student T: "800 MHz"

Student Z: "800 MHz"

Student T: "That means the internal clock does..."

Student Z: "800 circles per second"

Instructor: "Only 800?"

Student T: "No, not 800.."

Student Z: "But they are MegaHertz"

Student T: "Eight hundreds millions"

Student Z: "Eight hundreds millions per second"

Student T: "Eight hundreds millions"

Instructor: "Eight hundreds millions "/"since they are Eight hundreds mega"

Student Z: "Since one Hertz is.."

Student T: "No, since it is MegaHertz"

Student Z: "One MegaHertz is one million"

Student T: "Yes, 800 million per s.."

Instructor: "Isn't true? One MegaHertz is one million, how much are the 800?"

Student T: "Per second"

Student Z: "Eight hundreds millions per second"

Instructor: "That's right, so it does eight hundreds millions circles"

Since the educational workgroup reached in some level of mutual understanding concerning cognitive object, it advanced in the last phase of reconstruction of model (IR). In this phase the students express what they have learned during scaffolding process (tID) reconstructing the model, selecting again relations between the entities properties. The model's execution constitutes once more teacher's initiative, since students do not have any reason for executing the model that will not confirm their choices. However as it appears in the following episode 3, the instructor has reasons for supporting the dialogue that results from the model's execution.

In episode 3, students, after having discussed with the instructor (tID), select new relations between the processor's specifications and the system's performance and execute the model after the instructor's initiative. During the model's execution, the instructor supports the dialogue so as to be explained in which way the model's behaviour corresponds in the workgroup's choices and in the real phenomenon that model represents.

3.3 Episode 3: The right relations execution

Instructor: "Let's try the other ones, let's run ... how we can test the other / open anything of them, open just one"

Student A: " This one"

Instructor: "Bravo, that's it / push the button there, very nice, run it!, press the button now / as you like, either step

by step or at once / no, this is not the step by step button, next to this is the step by step button / very nice, read now the value, internal frequency 4.77, execution time how much seconds?"

Student S: "55"

Instructor: "55, push again the button, is increased, let's see now, internal frequency 50 MHz, execution time?"

Student S: "Is decreased"

Instructor: "32 / 90MHz execution time 31 / 133 MHz execution time 30 / 200MHz execution time 30"

Student S: "Remains the same"

Instructor: "233 go on/ go on/ is it false?"

Student A: "Yes"

Instructor: "No, it is not false because.."

Student S: "Remains stable"

Instructor: "Do you believe that it is false? There is a relation. As much as if you increase the frequency, some moment the execution time doesn't..."

Student S: "Goes on"

Instructor: "The execution time is not altered, our computer is a system (mouse) in which doesn't play role only the internal frequency, but also the other attributes / let's run it a little in order to see / the internal frequency it increased, the execution time some moment is decreased, but some moment it stops, that's right? This isn't completely, isn't completely false / that's right? (it runs the representation tools of the relation) the internal frequency is increased the execution time is decreased, you see it? if we choose now a processor that is more modern, that has 3 GHz, that are this here, the execution time goes in the 30, that's right? But other attributes should also change in order to the execution time is more decreased, that's right? As long as the execution time is decreased, so much faster the program is, that's right?"

Student F: "Yes" (Student S shakes the head affirmatively)

Instructor: "So this is right, at least partly, let's go to the other"

4. Discussion – conclusions

From the short analysis that proceeded, it results that the educational environment in question and the activity's objectives placed by the instructor as well, shape the educational workgroup's communication structure. During the dialogue process supported by the instructor, it appears that mutual understanding is constructed between him and the students, having as a mental context their common knowledge.

During this discussion anyone would wait the educational workgroup had used also the recent collective experience with the environment's tools: the multiple representations of student's perceptions for the cognitive object, but also the simulation's execution of real phenomenon. Nevertheless this collective experience was not used for the construction of new knowledge. This is explained by the fact that collective experience was not incorporated in the wider common knowledge of both instructor and so as to

support the construction of mutual understanding about the cognitive object [1], [12].

Both representations and simulations of the educational modelling environment user's interface provide student's thinking support [4] not only when they are connected optically with what they represent (realistic representations-simulations) but also when this connection is recognized or is possible to be constructed by the common knowledge of the members of educational workgroup (teacher and students). In the particular framework the representations created by the simulation's execution constituted a symbols' system, that was not connected conceptually in all the cases of students with itself the phenomenon of processor's performance trial and test.

Thus the particular educational scenario appears that it did not ground sufficiently the discussion between the members of educational workgroup. Those did not have reason for using the model's execution tools since this initiative would not support their reasoning. Consequently, the all activity was converted by the instructive action so that it resembles more as conceptual mapping and least as semi-quantitative modelling as were the initial intentions of its designers.

Of course this does not mean that the all activity of using that educational environment's tools was not incorporated creatively in the instructive process between teacher and students. It did not offer at the level of grounding, but it created that dynamic environment carrying out the educational dialogue, structuring the communication so as a framework of investigation, but also endorsement by the instructor was created.

Simultaneously it gave the possibility of utilisation of alternative systems of symbols and representations, moreover native language and mathematics. Thus, educational workgroup members, under instructor's initiative, used the model's construction and execution tools in order that the students appropriate the symbol's system used by the educational modelling environment. At this point the role of mediation and framing of the educational activity by the instructor were, and it is we would say, very critical, since itself using of modelling educational environment tools it is possible to provide chances for creative discussion that concerns in the real phenomenon that is studied.

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