Usage of a Computerized Test Model in Physics and Astronomy in Bulgaria
(7th Grade *"From Atom to Space"* Section)

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Abstract. The article presents a specially designed computer test model for interaction between the physics and astronomy terms in the "*from an atom to space*" learning material. It facilitates the test examination of the students. There is a new dimension of teaching physics in high school with modern information technologies in the teaching process – many experiments can be visualized and understood easier by learners. The test system is also improved – instead to use a piece of paper and pen, students have tested via interactive computer programs. Teaching physics can be entertaining and successful for students when using traditional methods such as the world-known model of semantic memory of D. Rumelhart, Lindsay and D. Norman in combination with modern means for teaching and testing.

Introduction

Seven grade students are in the group of 13-14 years of age. This is the period of formation of diverse interests amongst them [1]. At the same time, their brain's abilities increase and thinking becomes deeper, their abstract thinking gradually develops.

The problems identified years ago while teaching the Chapter "*From atom to space*" are predominantly related to the abstract nature of the curriculum [2]. The majority of the physical objects such as atom, atomic nucleus, electron, proton, neutron, stars, galaxies, nebulas, etc., which are included in the subject of the study, cannot be directly observed neither in nature, nor under special laboratory conditions. These problems overcome by a comprehensive and interesting presentation of the material, accompanied by visual aids – schemes, drawings, paintings [7], photographs and most of all different models of objects and processes, primarily computer programs visualizing various processes, which are connected with the advanced abilities of students to retrieve information from schemes, diagrams and graphs.

In this section, students should learn the objects of macro, micro and mega world such as atom, atomic nucleus, elementary particles, planets, stars, galaxies, and nebulas [2]. The particular nature of the curriculum does not only develop pupils' abstract thinking, but it also broadens up their scientific horizon about the world.

The basic concepts (some of them mentioned hereinabove) as well as the main relations (the formula for the mass number, the law of gravity) should be learned by the students to the level of understanding, without requiring very close reproduction of the definitions in the textbook.

The enhanced cognitive abilities of the students at this age allow the application of different models in teaching physics and astronomy [1]. Because of this effect, the author has developed a program, based on the model of Rumelhart, Lindsey and Norman. Two main principles characterized it. They would be perform in a way, which allows the application of many models of learning, and practical activities are influenced by the enhancement of the skills, but should not necessarily affect the initial gaining of knowledge.

The Model of Rumelhart, Lindsay and Norman

Rumelhart, Lindsay and Norman suggest that there are three methods of learning: accumulation, structuring and perfection [3]. Accumulation is adding new knowledge to

the existing memory. Structuring includes the formation of new conception structures or schemes, while perfection is the adaptation of knowledge to a certain task, usually through practice. Accumulation is the most commonly used form of learning, structuring is used less frequently and requires substantial efforts, and perfection is the slowest form of learning and it explains the presentation of knowledge.

Restructuring includes some forms of reflection or insight (e.g. self-consciousness) and may be associated with the presentation. On the other hand, perfection often seems to be an automated behavior that is not accessible for reflection (e.g. learning procedures, lessons) [3].

Rumelhart, Lindsay and Norman complete their model by including similar processes in it. They create a new scheme by modeling the already existing one, which is then converted based on future experiences.

Norman gives an example with the learning of the Morse code [4]. The initial code learning is a process of accumulation. Learning to recognize the consecutive Morse characters or whole words is restructuring. The gradual increase of the speed in transmission and reception demonstrates the perfection process.

Memorizing concepts according to the model of Rumelhart, Lindsay and Norman

Concepts are the most important information stored in memory, and no adequate mental activity is possible without it. A person knows thousands of words, most of which are verbal labels of concepts, and a number of concepts without such labels are stored in his memory [6]. Only because of the fact that the concepts are included in a network of complex relationships, they can be explained even when they do not possess their own verbal names.

The essential part of the contents of some concept has revealed through its interrelations with other concepts in the long-term memory. It have established in the analysis of the semantic structures that the following interrelations predominate among the whole variety: 1. Relation of a class reference, which means that the defined concept belongs to it; 2. Relations leading to properties that separate the certain concept from all representatives of its class; 3. Relations directed to examples – specific representatives of the defined concept [6].

According to the model of Rumelhart, Lindsay and Norman, long-term memory consists of rectangles (conceptual nodes) and arrows (links between the concepts). Arrows have two properties – they have direction and significance. It has known which node arrows to know from where to start and to where end. The reverse direction is possible either, but then the significance of the arrow changes. So, one of the three inscriptions – class, property or example has attached to each arrow [6].

According to the model of Rumelhart, Lindsay and Norman, there is a definition of a concept in the informational data base memory, that includes only its immanent (intrinsic properties) – primary concepts (e.g. velocity). Besides, in a specific situation the concept will need further definition, which contains some more specific or situational properties – secondary concept (e.g. instantaneous velocity, average velocity, etc.) [7].

Platform

The program, which has proved its unique interactive, multimedia web or Stand Alone based products, has developed by means of Adobe Flash. Essentially flash is a remarkably successful symbiosis between a vector graphics program and a programming environment. It possesses powerful tools for drawing and importing bitmap images, as

well as the perfect integration with acknowledged design programs such as Photoshop and Illustrator. However, one of its biggest merits by which it excels the traditional vector and raster applications, is the possibility to create animation and interactivity. All this allows the creation of an adequate, appropriate and most of all exciting and interesting graphic image of the application for the target audience.

Besides, flash provides the opportunities of the object-oriented language action script 3 for the program realization of the product. It has based on ECMA Script programming code used for the creation of Adobe Flash videos and applications in the widest range – games, recreation and management of audio and video streaming, online communications like chat programs and much more. Proveding its advantages in creating game applications a long time ago, it has appeared to be very suitable for achieving the objective set. Its remarkable plasticity and its almost countless opportunities to work with objects allow the creation of flexible functions for data processing, building in external modular content, working with user-defined classes and creation of randomly generated content and terms of tasks, which is included in the present product.

The latest version of Adobe flash – CS5 offers a variety of innovations in the construction of multimedia applications. Amongst them, the opportunities for three-dimensionality, rotational and perspective transformations, as well as the skeletal animation are of the greatest interest. Of course, this is a pseudo 3D, based on static perspective. Much better results are achieved through the incorporation of additional sets of classes, for example the free Papervision 3D and Away 3D. With them, it is possible to use three-dimensional objects with polygonal structure, NURBS and figures with subdivided planes and to control cameras, lights, effects, etc. With their help, the flash movie can turn into a real three-dimensional simulator.

The potential of the MDM Zinc software has used for the final design of the product, which extends Flash's functionality in creating Desktop applications. This has achieved by a secondary compilation and installation of additional classes, many of which may correspond directly with the customer's operating system. Zinc simply turns the swf files, created by flash into separate applications that do not need additional software installation – in this case, it is Flash Player. The only thing to do for operating with the product is to start it. Another new remarkable possibility of Zink is to compile executable files for Linux and MacOS, and such platform independence is an indisputable advantage for every application.

Description of the Application

The Model of Rumelhart, Lindsay and Norman has taken into consideration in building up the computer scheme, because it takes the hierarchical structure between the concepts into account. As a result, of using the theoretical model of Rumelhart, Lindsay and Norman with selected physical concepts a hierarchical tree has obtained which has used for the development of the program. The idea of the logical puzzle is at the basis of the program. Thus, important concepts and terms of the subject physics and astronomy for 7^{th} grade students may to be learning in the form of a game, arranged in an orderly hierarchical structure. The student may see a logical scheme on the screen, with randomly missing elements (Fig. 1).

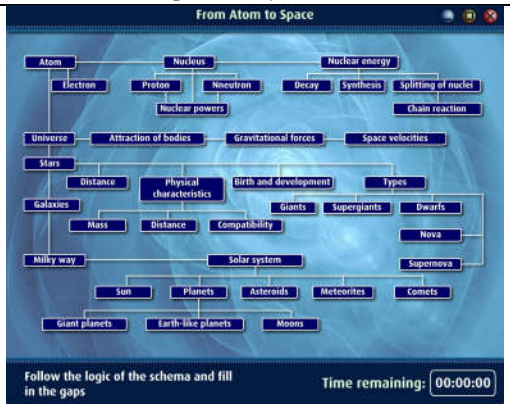

Fig. 1 *Logical scheme with randomly missed elements*

In terms of programming, this has achieved through defining a function for the generation of random content. Each start of the application fills in or does not fill in the randomly selected elements of the scheme, preserving the overall hierarchy. Following the logical principles and using their knowledge, the students should add the missing elements. The problem has solved for a precisely determined time interval controlled by the timer in the lower right corner of the application.

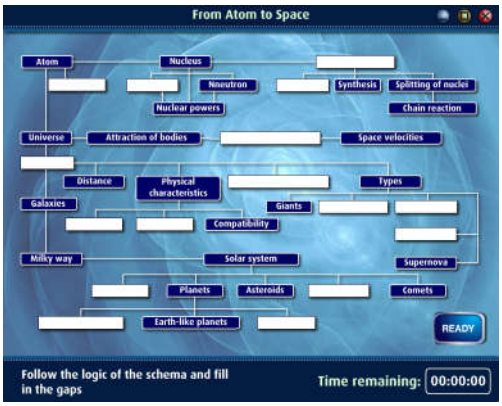

Fig. 2 *The program deletes only the wrong answers but records the number of the attempts and the number of the wrong answers*

When the student presses the "READY" button, the program assesses the information. If the information is completely accurate, the timer stops, the completed scheme appears together with a floating window with a greeting and report for the time needed by the student to complete the task. If the information contains incorrect data, the student receives a warning message. The program sends him back to the logical structure to correct the mistakes. Each time the program helpfully deletes only the mistakes (Fig. 2), but it also records the number of attempts and the number of the wrong answers.

This continues until all the elements have correctly filled or until the time for solve the problem expires. In the first case, the student receives a greeting message and statistics for the time of completing the task, the number of attempts and of the mistakes (for each of the attempts). If the time expires and the logical scheme has not completely filled in, the student receives a message that he has not coped with the task and has to try again being better prepared. Then, the completely logical structure appears and the missing answers are visible (Fig. 3).

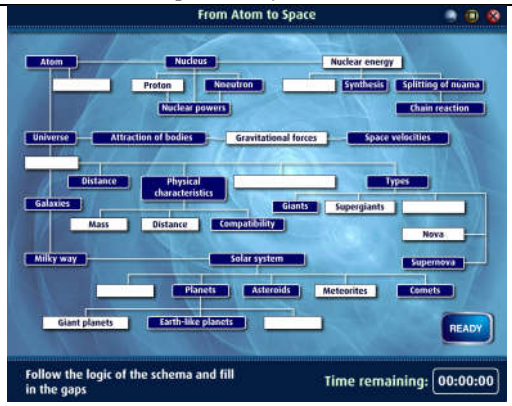

Fig. 3 *The whole filled in logical structure showing the missing answers*

The game may to be further developing to save results with other personal user information, such as name, grade, etc., depending on the context of its application. For this purpose, it would be necessary to write the relevant functions and modules for writing in XML, database, text file etc., and to develop the relevant interface for the submission of personal data.

Conclusion

The rapid development of computer technologies in the recent decades requires an active development of various computer programs, which would satisfy students' constant aspiration for new and various educational models, especially in a difficult subject such as physics.

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