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Mathematical Education with efficient Virtual Teacher

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Abstract

This article discusses critically important problems in mathematical education and proposes certain ways to fix them. The educational system "Virtual Teacher" was developed for "Calculus" in Ukraine's mathematical educational system.

1 Introduction

Mathematical disciplines are widely seen as complex areas which are difficult to master on your own. As noted in [3], "Mathematics and science in general are often presented as cold and sterile. In truth, the process of creating new mathematics is a passionate pursuit, a deeply personal experience, just like creating art and music", "Mathematics equals rigor plus intellectual integrity times reliance on facts".

There are a lot of debatable aspects of mathematical education discussing the critical problems of how hard Mathematics is. We have a few suggestions

to fix that and we propose new approaches to get the mathematical knowledge quickly and comfortably. In addition, this knowledge is powerful and efficient. Looking through the history of mathematical teaching from preschool to university [4] [2], we could note that visuality and technology are important means. Some problems explored in [1] [7] from the pedagogical view and how efficient it is to teach students using interactive communication and visual information.

Despite the existence of big educational technology companies like iTunes U, Coursera, edX, Lynda, Khan Academy, Udacy, Udemy where students can pursue their knowledge, these offer mainly remote courses. They are not like a virtual teacher who can direct students the right way by adapting the educational processes on each step. That is where there is a sense to look for modern technology to build the educational platform where each student will be able to learn on their own and ask questions.

2   Mathematical Education

A creative perspective to consider the world of Mathematics is to see it as a sum of facts which we need to put together to build a solution to the problems that have not been solved yet. As Georg Cantor said: "The essence of mathematics lies in its freedom" and Dan Meyer noted that "Math is the vocabulary for your own intuition". It means that mathematics is interesting in a way that it makes almost everything in life easier. Sometimes just a little easier, sometimes a lot easier. In a way it is like speaking another language.

When dealing with a problem, we should find the answers to a couple of questions from the mathematical point of view. The main thing is a level of abstraction. We can see the same subject but from different perspectives. It means we can build the different mathematical models. What are the key properties and parameters to find the relevant solution? Where is the expected result from? The second direction is ordering the necessary information. The global task for any applied mathematician is to create the model what is close to the real subject.

To weigh the situation around the educational process and shift the focus to mathematical education we will describe key points to look at certain problems to get certain results. What happens is when a student decides to master the skills of the mathematical language, he/she is bombarded with formulas and other information which often makes life miserable.

What motivates you to choice Mathematics?

- Accuracy and abstraction beauty of mathematics.

- Passion for mathematics.

- Significant opportunities offered by applied mathematics.

- Logic and rational skills.

- Thirst for knowledge which will help explain many of the phenomena of the modern world and the desire to learn more about the world.

- Acquiring new tools to solve problems that arise in life.

Why have you lost your passion for studying?

- A lot of attention is paid to theory.

- Little explanation which can help to use the solutions in real life.

- The teacher's explanation is too fast, no clear illustration on the board.

- There is no explanation of the reasons why certain concepts and mathematical objects are introduced.

- No relationship among the branches of mathematics.

- Vector interest gradually shifted under the subjective factors.

- When important aspects are lost it causes more misunderstanding resulting in loss of interest.

What could we do to improve the educational process?

- Reemphasize important information that the student needs.

- Summer/winter practical training to apply the knowledge.

- Provide more background why a course is important and what ind of problem can be solved by learning it.

- Encourage interdisciplinary courses.

- Whenever possible, jndividualize instruction to fit the educational levels of students and monitor their progress.

- Allow students to create the problem to use the wingspan of their creative spirit and apply the knowledge they already have.

3   Virtual teacher

The way students get knowledge and have it checked is changing due to modern technology. The relevant direction in this case is automation of the educational process. One of the efficient ways is Virtual Teacher (VT) which contains an e-book to get knowledge, train skills and check progress (Fig. 1)

Figure 1: Schema of the Virtual teacher software

VT could be used to increase the level and quality of mathematical education in tertiary education institutions. We can create a variety of VTs for different topics. The whole sense and the algorithm of getting knowledge will stay the same.

The system "Nesvit" was developed to augment the virtual teacher. Based on this system, we created the VT for "Calculus".

"Nesvit" system includes the instrumental system of the formation of didactic material and the body of Virtual Teacher. The third part of VT checks knowledge being automatic and tracks each step of learning.

The main concept to create VT is algorithmization of the educational material according to the target setting. It means the training material should be properly structured and its architecture should be clearly defined. In

accordance with the architecture of the educational material, the development system generates a control logic and performs the layout of educational material for further use by Virtual Teacher.

Virtual teacher allows one to define the objective of study, to learn the theoretical material, to get the practical skills and to check one's knowledge. In particular, the VT of mathematical analysis allows one to select a chapter and the relevant topic. Getting started with the VT suggests the user registration: entering name and group.

Electronic textbook (e-book) is the first part of VT used for the study of the theory. An e-book provides a didactic material formed by a common purpose and submitted in electronic form. The hypertext structure of these books provides a detailed description of certain concepts from the main text, displays the graphics and colorful animations with links one can click on. An e-book can be developed, for example, using HTML, PHP, FLASH and other technologies. Since it is based on the principle of clarity, it improves the perception of the material and promotes effective learning.
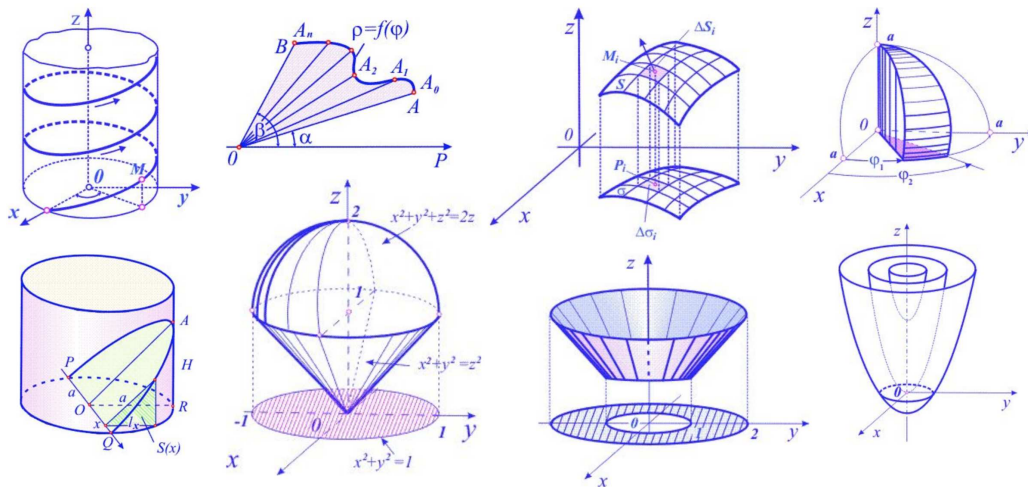

Figure 2: Visuality part of the Virtual teacher software

It is a fact that students learn visually (Fig. 2) much better (for instance, when the material is colorful and with dynamic effects). Another fact is that understanding is reinforced through dialogue. No matter how many times a teacher explains on the board, most students do not actually understand a concept until they do it on their own and learn from their mistakes.

As part of practical training in class the usual communication is dialogue

and discussion. At this stage of knowledge, the teacher plays the role of a guide. who directs students In the "Nesvit" system that way is the second part of VT and it is called e-training. E-training is a software which sets a platform of active dialogue between VT and students and it shapes their skills and abilities to apply the theoretical methods.

E-training provides an interactive dialogue in accordance with the target set for each activity, using logical decomposition, methodical and psychological elements. The process of solving practical problems has been built through interactive conversation and expanded through a rational algorithm to the steps where the student has to give an answer at the each step. Using previous knowledge and logically coupled topics, these steps contain new knowledge on a current topic. Thus, answering the questions is constructed in a logical sequence, forms a common algorithm (Fig. 3) and the practical skill of the methods of the subject.

Integration of formulas and a text editor allow to analyze the responses entered in arbitrary form, taking into account the basic associative and commutative properties, and text responses taking into account synonyms.

Answering an open-ended question involves entering verbal, numerical or symbolic information on the keyboard. This answer record form does not limit the student, but at the same time it requires clear and concise language. Moreover, the more complex the dialogue, the more intelligent the learning process, which is a major factor in the growth of quality of training.

To enrich the intellectual capabilities of the Virtual Teacher uses elements of a sophisticated approach in the organization of the dialogue.

The automated system of differentiated knowledge control and recording enables one to store and analyze each student's progress for each session building up his/her "learning history" and gives the teacher the opportunity to correct the strategy.

Knowledge assessment is carried out through answering each question and takes into account the number of attempts to give the correct answer and the time. In the training mode, scaled scores encourage the student to revise the theoretical material. In the monitoring mode, they measure the student's knowledge and are entered into their grade book. The Monitoring mode is logged and is available for viewing and printing out as a hard copy. Thus, a single software product electronic textbook, simulator and knowledge control system have all merged to create a new kind of didactic material-Virtual Teacher. This VT can be an effective tool for improving both teaching methods and students' motivation to work independently. The possibility of training with VT enables each student to learn at their own pace, according
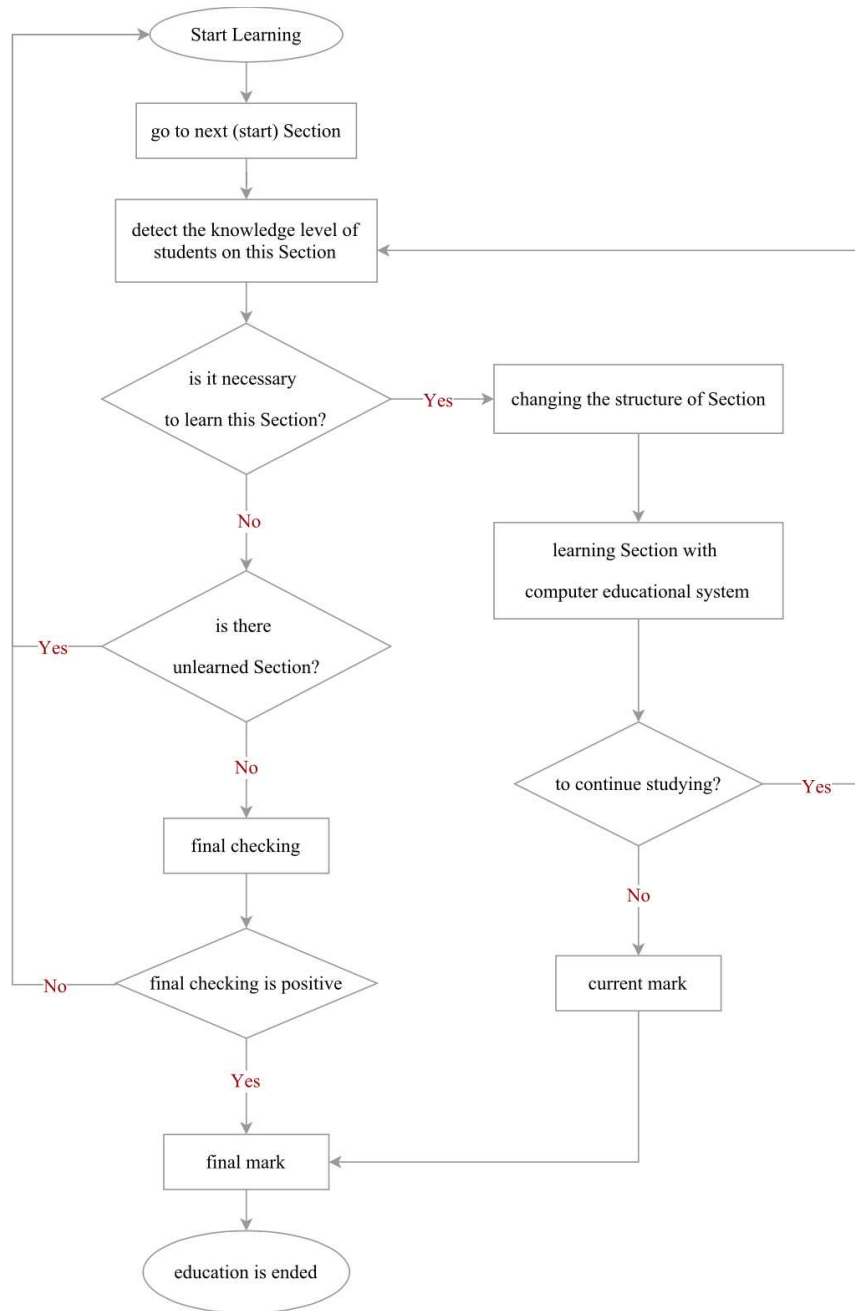
Figure 3: Adaptive algorithm for Virtual teacher

to their psychological characteristics, speed of perception and assimilation of educational material at any time.

In traditional education, there are certain restrictions on the learning curve, if the student is ready to have their knowledge controlled well before the end of the studied section, which leads to certain problems and difficulties. There are no such limitations with a Virtual Teacher. An electronic tutorial, training and monitoring systems are available to students at any time. They are free to choose the time and the amount of material and for two or three days of intensive training to learn and to pass the relevant section or topic.

With a virtual teacher the students have learned the material 30 % more successfully in a comparative study (over 13 years) for the topic "indefinite integral" at Kharkiv National University of Engineering and Architecture. The feeling of uncertainty and fear of giving a wrong answer are reduced by use of a Virtual Teacher. The computer program also motivates learners and tries to keep them interested.

The work with Virtual Teacher of mathematical analysis does not require special training. The graphical interface is designed in such a way that the actions to be taken are quite obvious and there should be no doubt about the purpose of a button. Moving the mouse pointer to the button, there is a detailed description of the action to be performed when the button is pressed. In case you still have problems, you can refer to "Help" and get detailed information about the operation.

Creating a Virtual Teacher, using the method of Socrates, and a customizable level of sophistication, its proper intellectual training and monitoring system allows you to study the theoretical material, to obtain practical skills and knowledge.

This software has been awarded diplomas from the Council of Rectors of Kharkiv University Center as well as an award from the Department Head of Education and Science of the Kharkiv Regional State Administration for being the winner of contests of educational monitoring programs and exhibitors at "Kharkiv Universities", "Kharkiv Region Science".

Using a virtual teacher enables one to intensify the learning process, reduce the time needed for assessing the students' knowledge and improves quality of student performance.

The copyright for computer program "Virtual Teacher of Mathematical Analysis" is protected by the State Department of Intellectual Property, Ministry of Education and Science of Ukraine.

Introduction of a Virtual Instructor in the educational mathematical environment will provide new ways of training which will make it a modern response to the needs and prospects of the scientific and technological domains.

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