Design of Adaptive E-Learning for Logic Operations

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Abstract:- Over the last decade, the concept of e-learning has become an important topic. E-learning today gives the student a central role in his/her own learning process. It allows students to try things out, participate in courses, tests and simulations like never before, and get more out of learning than before. In this paper, an adaptive e-learning environment for logic gates, simplification of Boolean functions and related fields is presented. The presented model generates suitable courses for each student in a dynamic form. The proposed environment is designed by integrating visual basic, flash and other effective tools. The contributions of this paper are supporting adaptive e-learning environment to improve learning and an evaluation of its use in context.

Keywords:- Adaptive E-learning, Information Visualization, Boolean Functions, Logic Operation, Digital Design.

I. Introduction

With the blooming of technologies, the popularity of electronic learning programs enforces us to think about what advances technologies can enhance learning depth, involve learners with the material, increase material retention, and improving education quality [1-8]. In traditional lecture methods, the professor acts as transmitter and students listening in a passive way, unlike in active learning students doing, observing and communicating, so they become more interactive by finding better ways to engaging them in learning process. Blended learning is defined as learning that combines instruction lead learning with online learning activities leading to reduced classroom contact hours. It has the potential to increase student learning while lowering attend rates compared to equivalent fully online courses [11]. Blended learning is the learning paradigm that attempts to optimize both traditional learning and distance learning advantages, potentials, and benefits while eliminating both learning paradigms shortages and challenges. Nowadays blended learning is commonly referred to as E-Learning. When compared to traditional learning paradigm, blended learning is found to be consistent with the values of traditional learning paradigm adopted in almost all higher education learning institutions for decades, and has the proven potential to enhance both the effectiveness and efficiency of meaningful learning experiences. In designing our model, we considered some basic principle for active construction learning model [12] including the following:

1-Learners participate in learning process effectively
2-teachers have an instructive role, instead of transmitting information in materials to learners directly.
3- Assessment procedures should be embedded in the learning process

The concept of digital logic has important use in all of today's digital computers and devices. It has such a prominent role in every day life in recent digital age [13]. Digital systems are used in communication, traffic control, medical treatment, space guidance, weather monitoring and other huge enterprises [15]. Our proposed model can be used as an adaptive e-learning tool for active learning not for logic design course only but also for all educational courses as image processing, computational models, principles of programming languages, compiler design, and other related courses.

Important topics are covered in our proposed environment. Such topics are integrated into a single environment using visual basic. So it appears to be portable, and machine independent, which makes it a useful tool for interactive and collaborative learning environment. The environment integrates several different materials to support the learners' preferred style. It includes a movie-like welcome component, an animated hyper-text introduction for the basic concepts, self assessment system, a logic gate simulator, a set of visual examples for learners' motivation.

Before writing this paper, several classroom experiments were carried out for the framework as a model of adaptive active learning tool. The preliminary results were clear in improving the learners understanding, performance, and increase their motivation. It is proved that the proposed model is easy to use and attractive for learners.

II. Related Work

Several models have been developed to make use of growth within internet based technologies [9,10]. For example, in

[14], the authors realized a Java programmed testing system, which is a component in an Internet based Digital Logic Design Virtual Laboratory realized to the stage of tasks delivery. A set of virtual instruments are at the disposal of the laboratory. Each instrument is designed to be used by the students to present the decisions of tasks of distinct type. The test consists of a number of tasks. Every teacher defines a desired number of tasks which are stored in a database. Another application presented in [20] based on Adobe Flash and SCORM within a MOODLE learning environment, which provides individualized assignments for students learning digital systems. The assignments are evaluated automatically and the result is reported to the MOODLE platform. Since the tasks are solved by the students remotely and unattended, students get their personalized assignment by selecting one from the pool of available assignments based on the student's unique learner id. While [16] presents an overview of an e-learning system and discusses some web-based tools for teaching the basics of digital logic in such a system. Also [13] presents a web-based system aimed at teaching logic design concepts and practices for computer science and engineering students implemented using LabVIEW. The experiments which include digital logic gates, combinational logic circuits, seven segment display, sequential logic and counters are easily constructed and performed, both in traditional and online setups. Vladimir Mateev [17] provides a Web-based virtual instrument for testing students' knowledge to construct truth tables of analytically-defined Boolean functions. It is a component of the testing subsystem of the Internet based Digital Logic Design Virtual Laboratory (DLDVL) that can be used from authorized users only. The instrument is realized as a Java applet. In [18] the authors use an interactive learning tool in the theory of computation course. Also [19] supports active learning to improve learning in computational models. Mohamed Hamada's environment [12] allows learners building coding process step by step and they can get help at any step of learning process using hints or help buttons. This environment provides a single interface java applet as a web-based tool in information theory. Due to the importance of virtual reality, [17] provides automata learners with a web based virtual environment for automata theory as an example introduced, and owing to the importance of active learning in higher education universities. Mariko-susumu [21] proposed a simple and effective model to represent a framework for adaptive e-learning systems. Also a web Services based e-learning architecture is proposed in [22]. In that paper, a function to modify the sequence of learning materials automatically due to learner's learning style is designed. Such function provides learner-adapted contents, which is incapable of conventional e-learning architecture.

III. The Proposed Model

The presented model provides a basic treatment of digital circuits and the fundamental concepts in their design. It is suitable for use as an introductory course in an electrical engineering, computer engineering, or computer science curriculum. Learners usually found logical design materials boring and complex. That's because the learners find materials difficult to visualize or even interact with. Especially when material includes coverage of low level electronics, electronic circuits, Boolean function, combinational logic and Karnaugh map then learners can lose interest or perceive higher levels of complexity.

The choices of effective e-learning tools are seemingly endless, according to availability of multiple tools. We integrate visual basic 6 with flash and other tools as an example of simple active learning tools that improves the learner's performance in classes. The implemented framework contains four components which have been integrated into a single unit to make all topics easily accessible for learner as shown in Fig. 1. The components include the following: Courses component (movie-like), logic gates model simulator, testing system, and visual examples. We will describe all our environment components. The framework generates the module course according to the understanding level of students. Here, teacher has an administration role in education process, but they also must construct the standard course material and other courses included in framework.

The course material is divided into 3 parts which contains plain and animated text as shown in Fig. 2:

1. Standard course: it represents main units ordered in an ordinary way that learners can be master successfully.
2. Review course: should be studied when a learner makes wrong answers in the examination as in Fig. 3.
3. Special course: course material should be studied when learner makes popular mistakes in the examination as in Fig. 4.
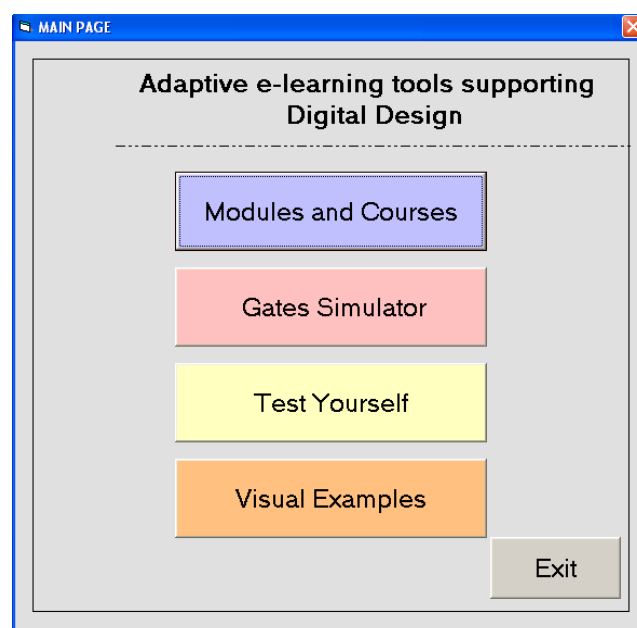
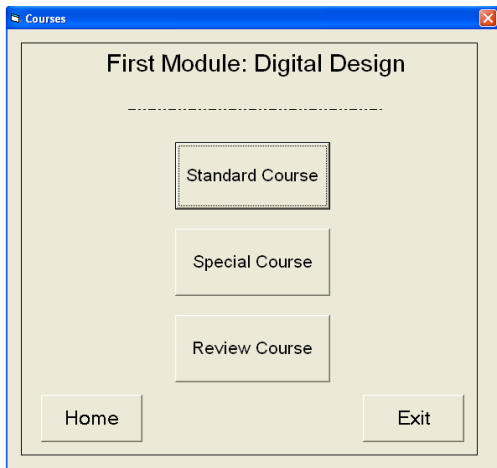Fig.1: Interface components in the framework.

Fig. 2: Three courses for each unit.
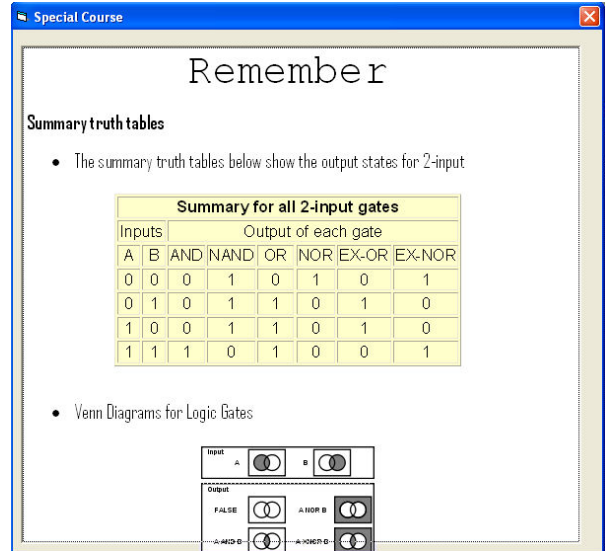

Fig. 3: Review course.

Fig. 4: Special course.

The logic gates simulator constitutes the second part of the framework. It contains an animated welcome page (movie like) illustrated with text and speech. Our simulator defines common logic gates found in digital circuits, and demonstrates course concepts. We provide links to pages where the learner can view symbols, truth tables, and animation of particular logic gates as in Fig. 5.
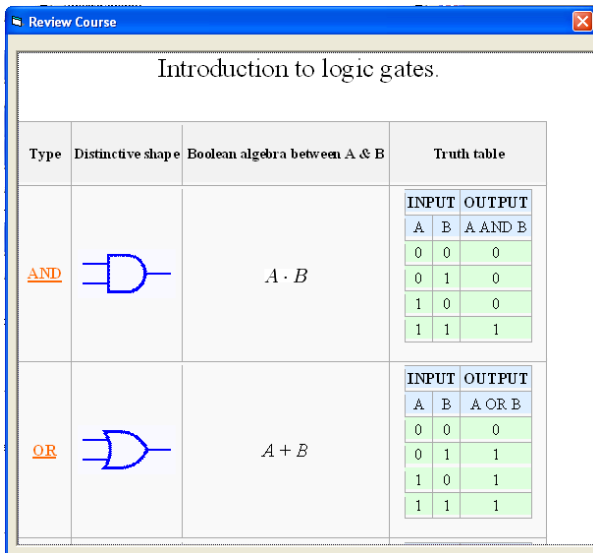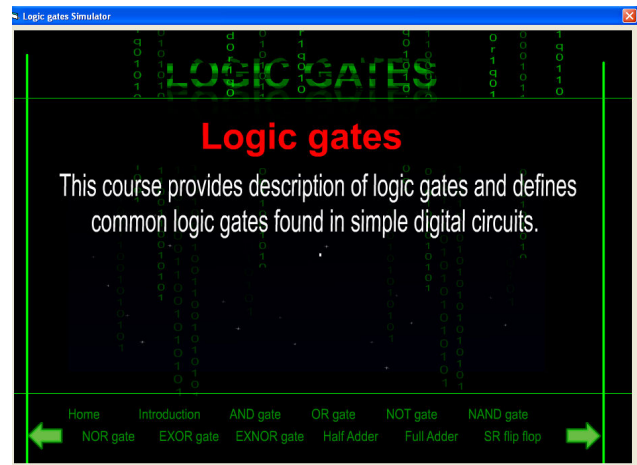

Fig. 5: Animated welcome page

Logic gates include *AND,* OR, NOT, NAND, NOR, EXOR, and EXNOR gates, in addition to Half Adder, Full Adder, and S-R Flip-Flop. In Fig. 6 shows the full adder, Fig. 7 shows the NAND gate and Fig. 8 shows S-R Flip-Flop.
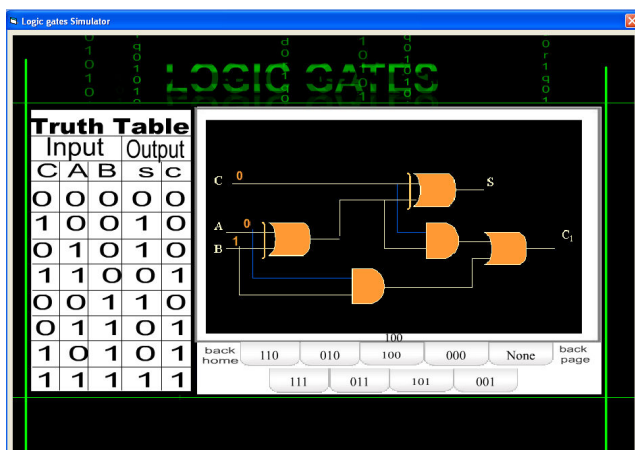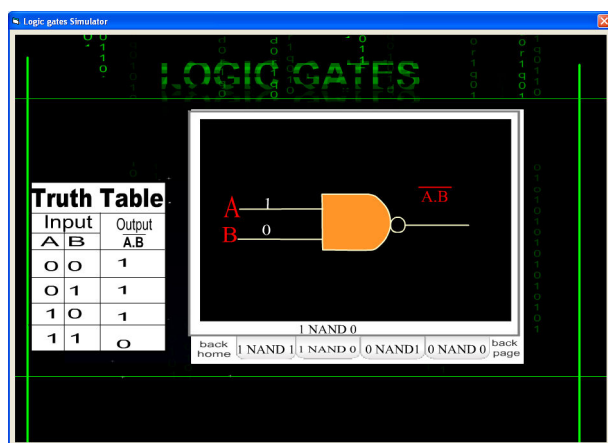
Fig. 6: Full Adder simulator.
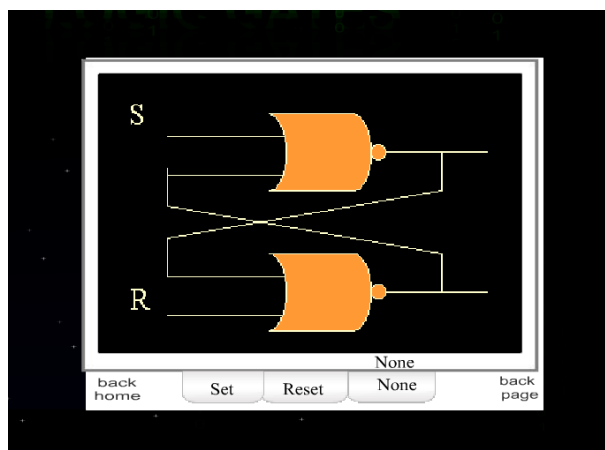

Fig. 7: NAND gate simulator.

Fig. 8: S-R Flip-Flop simulator.

In our simulation learners choose the input and see animated path through gate getting output in a repeated form. Learners not only watching how gates work but they

can get immediate help at any step in the learning process through navigation in the introduction components.

Some learners master a material course by studying it once. Other learners may not understand a material from the first time, so the situation must be different. Therefore our framework provides an examination mechanism. Such mechanism leads to other situations according to the exam results. The framework provides examination within 10 questions as a multiple choice questions that selected randomly from database contains pool of questions and their answers. A learner may fail to passes the same examination more than one time, or may be multiple learners examined at same time and place. So, the system generates different examination pages each time. It checks the answers by comparing the learner's answer to the correct answer in the database. It displays "Wrong" as a message in case of invalid answer, and if the answer is true "Correct" message will be displayed. The displayed messages according to answers are shown in Fig. 9 and Fig. 10. After the termination of the exam, the system counts passed and failed questions. It displays the final result in a score sheet and gives a comment on results. According to the result of the examination, the system decides the next course that will be learned. The system decides that special course material will be suitable as shown in Fig. 11. The system decides the next unit according to the following four cases:

1. If a learner's pass percentage of the examination of a unit is 50% or less, then next unit is a unit which the student has tried but never passed (learner returns to the same course that never passed by him).
2. If a learner's pass percentage of the examination of a unit is 60% or 70%, then next unit is the review course.
3. If a learner's pass percentage of the examination of a unit is 80% or 90% because of frequently wrong answers, then the special course materials will be provided.
4. If a learner's pass percentage of the examination of a unit is 100%, then the next unit will be provided.

The last component of our environment contains visual examples that demonstrate many of the fundamental concepts of digital design; it includes simplification of Boolean functions, Complement of a Function, Minterms, Maxterms, and Karnaugh map as shown in Fig. 12, Fig. 13. The question solved in a step-by-step manner, which can help the learner to interact with examples in an amusing way.
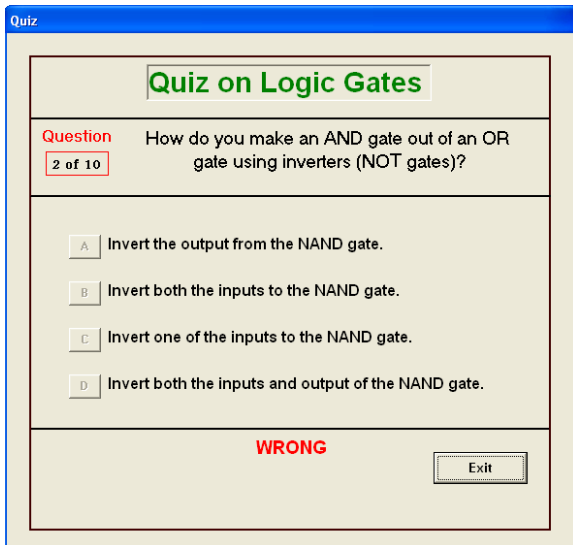
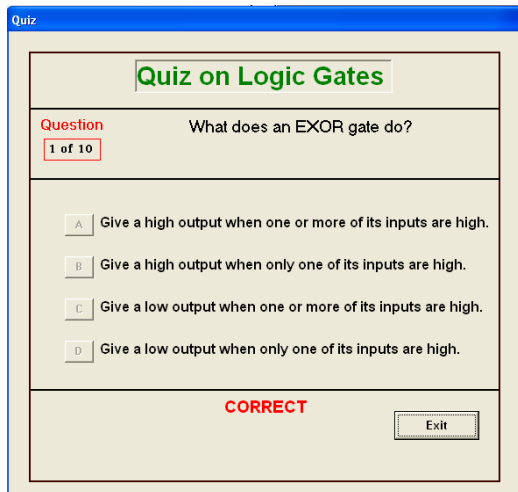Fig. 9: Displayed message if answer is wrong.

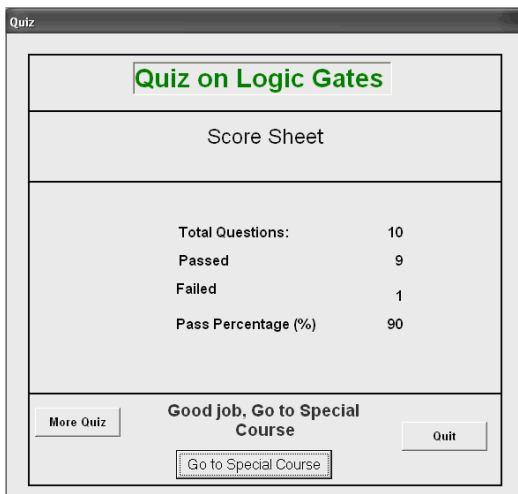Fig. 10: Displayed message if answer is correct.

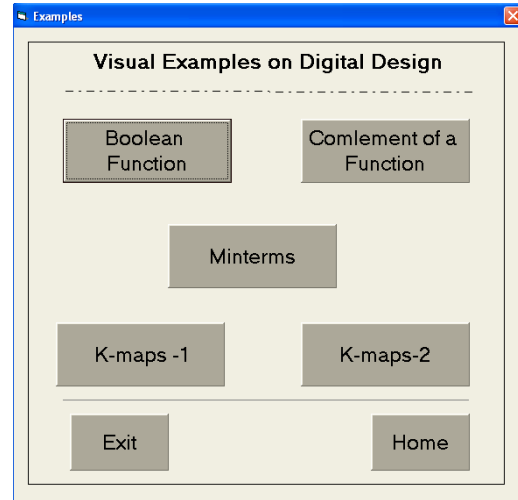Fig. 11: Score sheet and pass percentage.

Fig. 12: The interface of visual examples.

Fig. 13: Example on simplification of a Boolean function.

IV. Experimental Results

We carried out experiments in order to evaluate the effectiveness of our proposed tools on the learning process. Thirty students were randomly selected from different classrooms. They were divided into two groups, each one contains 15 students. The students of first group have already completed the logical design course and done their exams in a traditional learning process. Then each one of the first group was given the questionnaire as shown in Table 1. Then each one of the first group was given the questionnaire as shown in Table 1. The questionnaire measure five criteria named as increased motivation, flexibility, fairness, enjoyable, and pinpoint weakness. Five

options were given for responses: (N) No answer, (1) Poor, (2) Below average, (3) Good, (4) Excellent. The responses are shown in Table 2.

Table1: Questionnaire given for students.

Select suitable value for each question					
Questions	N	1	2	3	4
Do you find the learning process increases your motivation in learning logic design?					
Do you find the learning process flexible?					
Do you find the marks given to you fair?					
Do you find the learning process enjoyable?					
Could you identify your weaknesses in this course?					
N= "No answer", 1= "Poor", 2= "Below average", 3= "Good", 4= "Excellent"					

Table2: Results of the first group.

Select suitable value for each question					
Questions	N	1	2	3	4
Do you find the learning process increases your motivation in learning logic design?	0	3	4	5	3
Do you find the learning process flexible?	1	4	5	3	2
Do you find the marks given to you fair?	0	2	6	4	3
Do you find the learning process enjoyable?	2	5	3	4	1
Could you identify your weaknesses in this course?	0	4	6	5	0
N= "No answer", 1= "Poor", 2= "Below average", 3= "Good", 4= "Excellent"					

We demonstrate our model and visual examples for the second group of students. They have been allowed to use self assessment testing system, and each of them has been given the same questionnaire. Their responses are listed in Table3.

Table3: Results of the second group.

Select suitable value for each question					
Questions	N	1	2	3	4
Do you find the learning process increases your motivation in learning logic design?	0	1	1	7	6
Do you find the learning process flexible?	0	1	1	8	5
Do you find the marks given to you fair?	0	0	1	6	8
Do you find the learning process enjoyable?	1	0	1	9	4
Could you identify your weaknesses	1	0	2	6	6

in this course?					
N= "No answer", 1= "Poor", 2= "Below average", 3= "Good", 4= "Excellent"					

The questionnaire indicates that 86.6% of respondents conclude that the system helps increase their motivation level in learning logic design. The result also shows that 86.6% of the respondents thought of flexibility of the system. And 93.3% of the respondents agreed the marks awarded by the system were fair. 86.6% of the students found the experience enjoyable, two student did not like the experience at all, and. Finally 80% of respondents think the system could help them pinpoint their weaknesses in logic design course, while one student doesn't answer.

We compare results of the first group without using our model, and the other group used our model. For Choices N, 1, and 2, if the number of response decreased, it indicates a positive response, which is what occurred. While for choices 3, and 4, the increasing numbers of responses indicates positive response, which also occurred as in Fig.14.
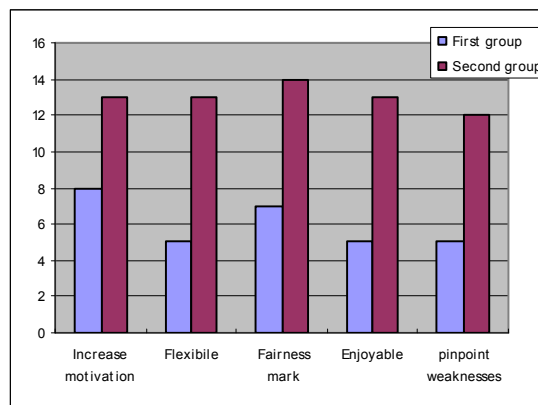

Fig. 14: Comparison between the results of the two groups.

V. Conclusion

An adaptive active e-learning framework has been presented. The proposed framework consists of four parts, self learning material, visualization in an interesting way, self testing, and visual examples. The framework is simple and easy to be implemented using simple tools to support adaptive e-learning systems for digital logic educational material, and it could be also used in other courses such as image processing, computational models, information theory, information engineering and digital communications. The framework finds a better way to

engaging learners in the learning process. Through the results of our experiment, it has been shown that our proposed model improves the learning process, and affects the students in a positive way. In addition an opinion poll showed a positive feedback on the environment tools from the students. In future work, we plan to enhance our tools by adding more features, visual examples, and make more performance evaluation experiments.

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