Fig.1: Interface components in the framework.

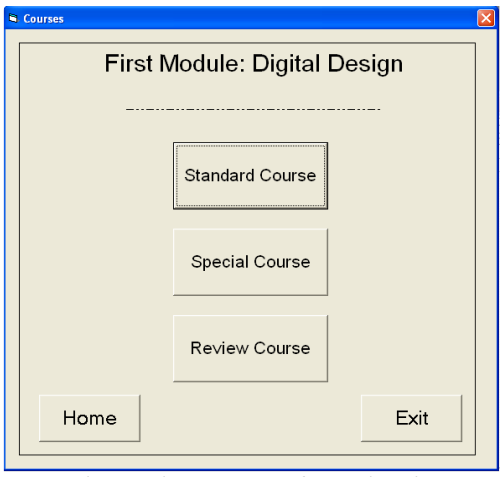

Fig. 2: Three courses for each unit.

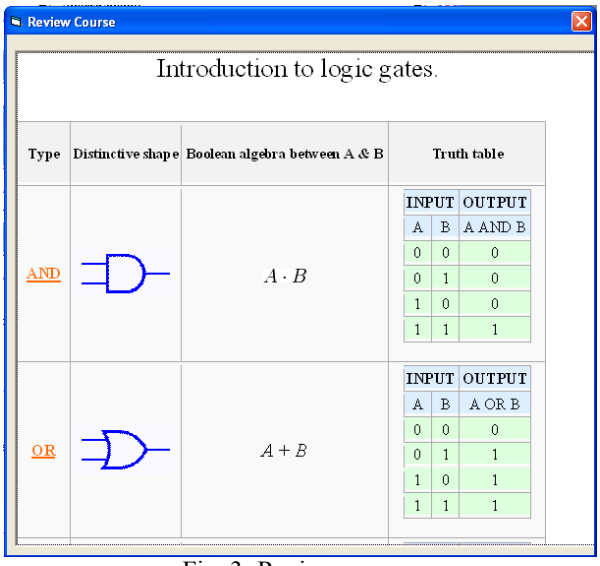

Fig. 3: Review course.

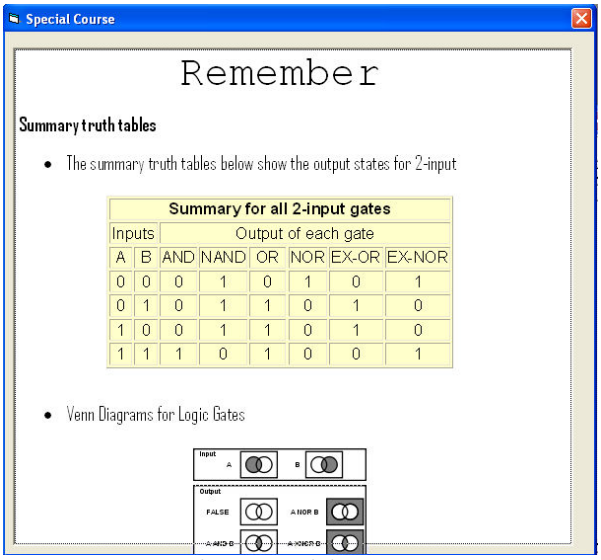

Fig. 4: Special course.

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.

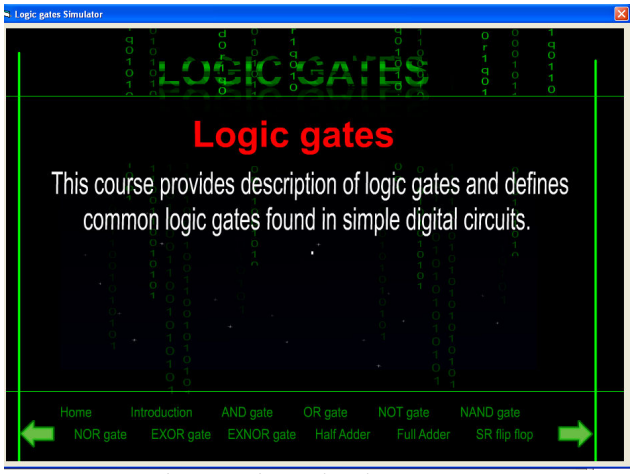

Fig. 5: Animated welcome page

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.

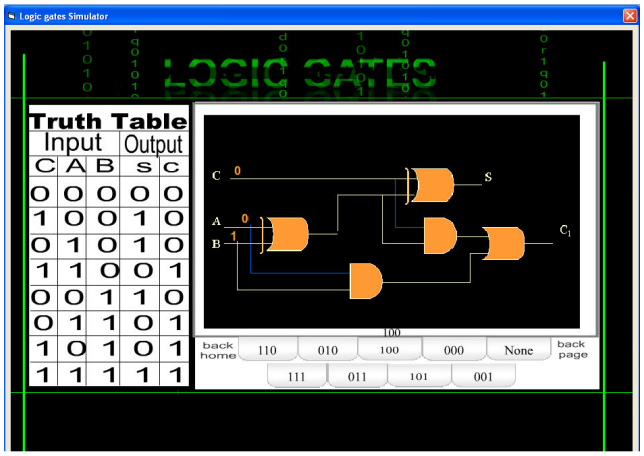

Fig. 6: Full Adder simulator.

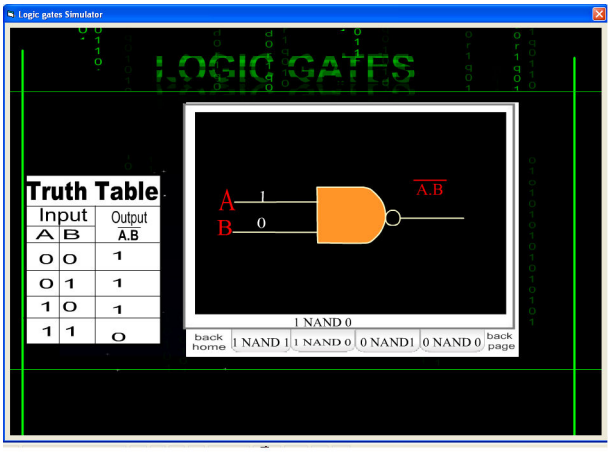

Fig. 7: NAND gate simulator.

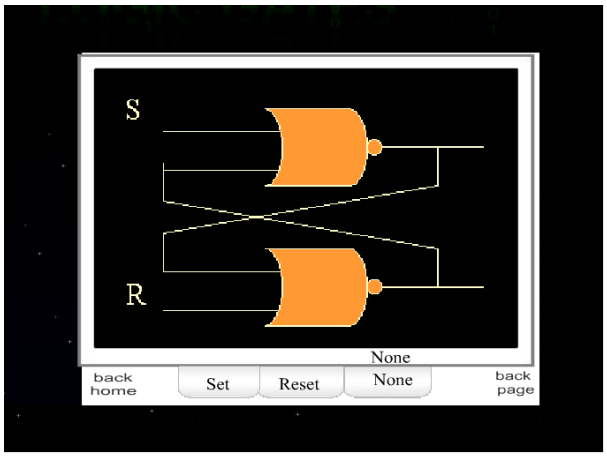

Fig. 8: S-R Flip-Flop simulator.

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.

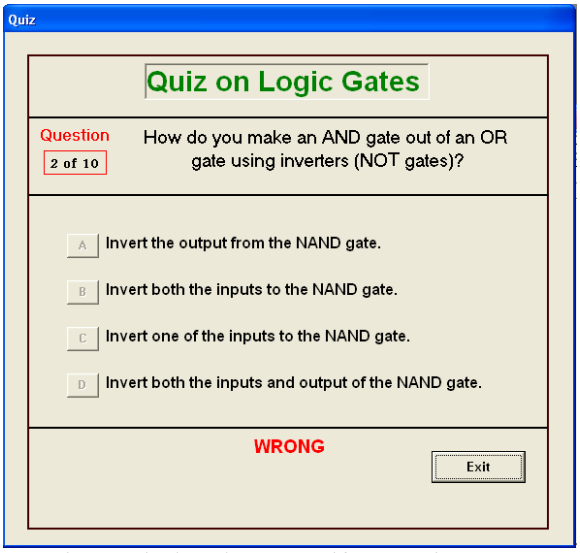

Fig. 9: Displayed message if answer is wrong.

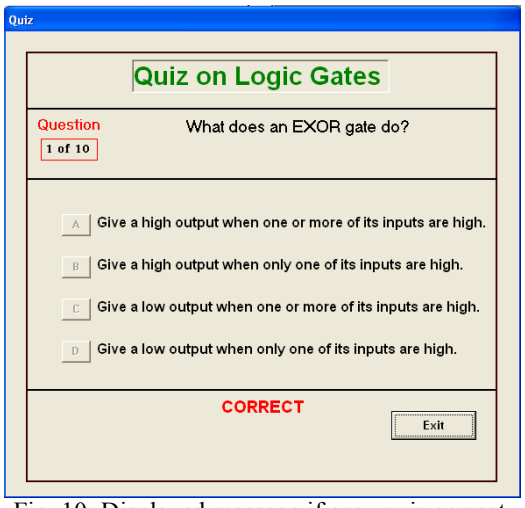

Fig. 10: Displayed message if answer is correct.

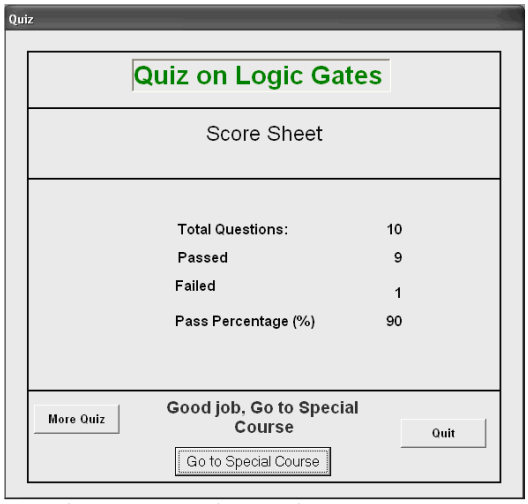

Fig. 11: Score sheet and pass percentage.

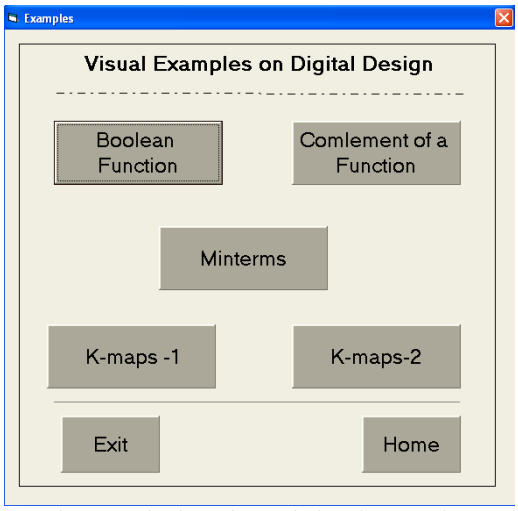

Fig. 12: The interface of visual examples.

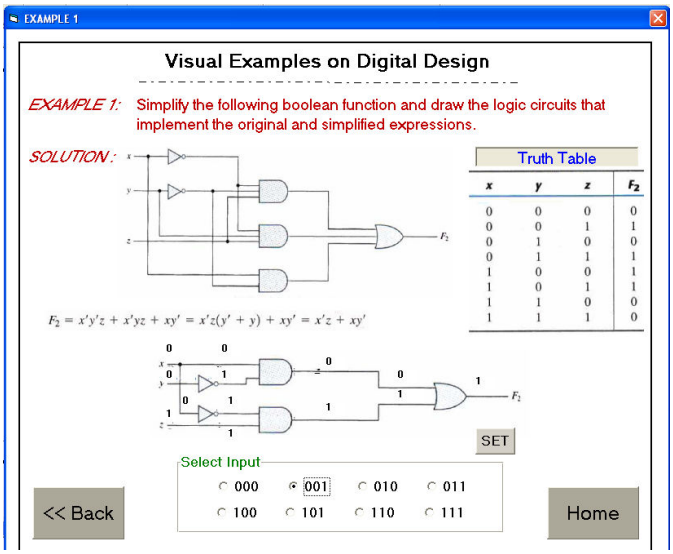

Fig. 13: Example on simplification of a Boolean function.

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 in this course?	1	0	2	6	6
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.

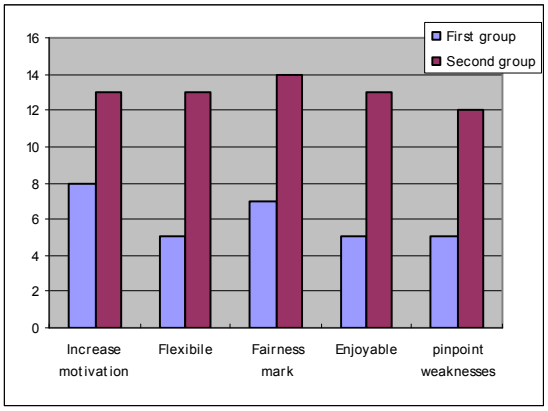

Fig. 14: Comparison between the results of the two groups.

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.

References

[1] Ahmed A. Saleh, Hazem M. El-bakry, Taghreed T. Asfour and Nikos Mastorakis "Adaptive E-Learning Tools for Numbering Systems," Proc. of 9th WSEAS International Conference on Applications of Computer Engineering (ACE'10), Penang, Malaysia, March 23-25, 2010, pp. 293-298.

[2] Hazem M. El-Bakry, and Nikos Mastorakis, "Realization of E-University for Distance Learning," WSEAS Transactions on Computers, issue 1, vol. 8, Jan. 2009, pp. 48-62.

[3] Hazem M. El-Bakry, and Nikos Mastorakis "Advanced Technology for E-Learning Development," Proc. of Recent Advances in Applied Mathematics and Computational and Information Sciences, Houston, USA, April 30-May 2, 2009, pp. 501-522.

[4] Hazem M. El-Bakry, and Nikos Mastorakis "E-Learning and Management Information Systems For E-Universities," Proc. of Conference, Rodos, Greece, July 22-25, 2009, pp. 566-574.

[5] Hazem M. El-Bakry, and Nikos Mastorakis "Modular Networks for Active E-learning," Proc. of 9th WSEAS International Conference on Applied Informatics and Communications (AIC'09), Moscow, Russia, August 26-28, 2009, pp. 373-382.

[6] Hazem M. El-Bakry, and Nikos Mastorakis "Activation of Informal Learning with E-learning Technology "Proc. of EDUCATION and EDUCATIONAL TECHNOLOGY CONFERENCE 2009 (EDU'09), University of Genova, Genova, Italy, October 17-19, 2009, pp. 245 -247.

[7] Ahmed A. Saleh, Hazem M. El-Bakry, and Mahmud Atta Alla, "Designing E-learning management system Frame work For Telecom Egypt training sector," Accepted for publication in Mansoura Journal for Computer Science and Information Systems.

[8] Hazem M. El-bakry, and Nikos Mastorakis "Design of Quality Assurance Management System for E-Universities," Proc. of EDUCATION and EDUCATIONAL TECHNOLOGY CONFERENCE 2009 (EDU'09), University of Genova, Genova, Italy, October 17-19, 2009, pp. 226 -238.

[9] Hazem M. El-bakry, and Nikos Mastorakis "Studying the Efficiency of XML Web Services for Real-Time Applications," Proc. of WSEAS International Conference on Sensors, Signals, Visualization, Imaging, Simulation and Materials, USA, November 7-9, 2009, pp. 209-219.

[10] Hazem M. El-bakry, and Nikos Mastorakis "User Interface for Internet Applications," Proc. of 9th WSEAS International Conference on Applied Informatics and Communications (AIC'09), Moscow, Russia, August 26-28, 2009, pp. 383-392.

[11] Charles D. Dziuban, Joel L. Hartman, Patsy D. Moskal, "Blended Learning", Vol. 2004, Issue 7, Educase Connect, 2004.

[12] M. Hamada. "Web-based Tools for Active Learning in Information Theory," to appear in the ACM SIGCSE, vol. 38, 2007.

[13] Al-Zoubi Abdullah, Jeschke Sabina Natho Nicole, Pfeiffer Olivier and Nsour Jarir, " Integration of an Online Digital Logic Design Lab for IT Education," Proceedings of the 2008 ACM Information Technology Education Conference, pp. 237-241, 2008.

[14] Vladimir Mateev, Svilena Todorova, Angel Smrikarov, "Test system in digital logic design virtual laboratory: tasks delivery," Proceedings of the 2007 international conference on Computer systems and technologies, June 14-15, 2007, Bulgaria.

[15] Damm, M., Bauer, F., Zucker, G. 'Solving Digital Logic Assignments with Automatic Verification in SCORM Modules', accepted at the ICL 2009.

[16] Robal, T. Kalja, A. , "Applying e-Environments in Teaching the Basics of Digital Logic," mse, pp.41-42, 2007 IEEE International Conference on Microelectronic Systems Education (MSE'07), 2007.

[17] Vladimir Mateev, "Virtual Instrument for Truth Table Construction of Analytically-defined Boolean Functions," International Conference on Computer Systems and Technologies (CompSysTech'08), 2008.

[18] M. Hamada, "Visual Tools and Examples to Support Active E-Learning and Motivation with Performance Evaluation," Lecture Notes in Computer Science, vol. 3942, 2006.

[19] M. Hamada, "Supporting Materials for Active e-Learning in Computational Models," 8th international conference on Computational Science, Part II, 2008.

[20] M. Hamada, An Example of Virtual Environment and Web-based Application in Learning, International Journal of Virtual Reality, 2008.

[21] M. Sasakura, S. Yamasaki, "A Framework for Adaptive E-Learning Systems in Higher Education with Information Visualization," 11th International Conference Information Visualization, IEEE Computer Society, 2007.

[22] Y. Tamura, T. Yamamuro, and T. Okamoto, "Distributed and Learner Adaptive E-Learning Environment with Use of Web Services," Proceedings of the Sixth International Conference on Advanced Learning Technologies, 2006.