

INTELLIGENT TUTORING SYSTEM (I.T.S) AS A TOOL IN ENHANCING STUDENTS PERFORMANCES IN MATHEMATICS

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ABSTRACT

The evaluation of intelligent tutoring system (I.T.S) is an important though very often neglected stage of ITS development. This research focuses on the implementation of an intelligent tutoring system for mathematics at secondary schools which can enhance the performance of students in mathematical sciences. In order to enhance the performance of mathematics skills in secondary school, this tutoring system can be used to tutor students at their leisure time in addition to classwork. Information will be readily available on the system for students to access and learn, using mobile devices or computers. Users of this system can take lessons and also test their level of comprehension at the end of every test. The advantages of the intelligent tutoring systems are: consistent tutoring technique, modeling of good practice, scaffolding, immediate feedback, recommendation, and motivation.

Keywords: ITS, Implementation, Mathematics, Performance.

INTRODUCTION

The index for science, technology and mathematics education has been acclaimed widely to be a pointer of measuring the socio-economic and geopolitical development of any nation (Betiku, 2001). Mathematics is one of the core subjects to be taken by all students up to tertiary levels of education among Science and Technology courses. It is one of the compulsory subjects. This compulsory nature of mathematics carries with it an assumption that all members of our society should have the knowledge of the subject. The competence of mathematics is a crucial and critical determinant of the post-secondary education and the options available to young people [2],[3]. However it is disappointing to note that students' performance in mathematics at internal and external examination has remained considerably poor despite the relative importance of mathematics (Ale 1989). Many variables have been implicated as factors responsible for discouraging performance of students in mathematics.

Mathematics has been the subject that is recognized as the mother of all learning with other subjects deriving their concepts from it, in both arts and sciences. It is also an international language and is essential in almost every field. Mathematics has also been regarded as king of all sciences, such as Chemistry, Physics, Biology, and Economics among others.

BACKGROUND OF THE PROBLEM

The performance of students in Senior Secondary Sciences in Nigeria has remained an issue of concern to all stake holders [5]. The report by [6] on the survey of the performance of candidates in science subjects in Nigeria over the years revealed a discernible decline. This perennial decline has remained a source of concern to science educators, mathematicians and mathematics educators [7].

Mathematics has been the subject that is recognized as the mother of all learning with other subjects deriving their concepts from it, in both arts and sciences. It is also an international language and is essential in almost every field. But it has been realized that many students have developed negative attitude towards the study of Mathematics as a result of mass failure of students in the subject. It is an irrefutable fact that the successfulness of learning the subject is contingent on myriad of factors. School, classroom, student and teacher factors all impinge on the learning of Mathematics. In particular, the seriousness or otherwise attached to the teaching of Mathematics invariably affects students' performance and has developed a phobia for the course among youth. Some factors which contribute to poor performance of students in mathematical sciences are described as:

- **Shortage Of Material And Human Resources**

Students attributed their performance in mathematics to shortage of mathematics teachers. Explanations given supporting the above point include: The few mathematics teachers available in schools could not teach all the classes in the school before the end of the day. Grade 12 learners normally had mathematics periods twice a week due to a shortage of mathematics teachers. Learners could not finish a lot of topics before examinations as a result of a teacher shortage. Teachers could not get time for remedial work due to an increased number of periods allocated to them. The students also attributed their high failure in mathematics to overcrowded classes and lack of mathematics textbooks for each of them [8].

- **Teachers Factor**

“Another factor is student-teacher relationship, it appears that most teachers that teach mathematics as a subject are not friendly, and in other words, mentoring of students is not a common practice among mathematical science teachers in middle school. Some act as terrorists due to some threatening statements they make while teaching, such as “if you are not careful you will fail”, “mathematics is a difficult course”, “do not expect an A score”, and “you cannot pass my course just like that” to mention a few. They lack the patience to attend to students' questions in the class, perhaps, because most of them are untrained teachers. They only know mathematics, but lack methods of teaching and psychological willpower to mentor their students through guidance and counselling for better academic achievements[9].

Also, “Students attributed their poor performance in mathematics to teachers’ behaviors. Explanations given by students to support this assertion include: Teachers absent themselves from school and classes; teachers insult students in class for giving wrong answers, do not motivate students in class and teachers always beat students in class” [8].

- **Lack of Appreciation**

The beauty of mathematical sciences courses is not easily appreciated by students. They pay little attention to mathematics when they do not appreciate its importance. Students should learn from a tender age (primary school), the importance and application of mathematics in their life calculating expenses, budgeting, and sharing out items in fraction.

- **Low self-esteem and self-confidence**

Some secondary school students from their primary schools misconceive mathematics as a difficult subject. You hear students and teachers saying “mathematics is a difficult subject”. The question is who said it? This statement is bound to scare students from making attempt to learn mathematics. With these misconceptions, they are already defeated, subsequently, causing them to fail. Fears arise from previous failures, discouragement from parents who did not perform well in mathematics, harsh attitudes of teachers, or comparison of low performing students to the top performing students. All these can cause students to despair and give up studies in mathematical sciences [9].

- **Poor Examination Condition**

Mathematics tests/examinations place with a set time for the examination, it has duration. In some mathematical subjects that are ascribed, because of the large number of students involved, approved teachers halls for such examinations are under-size, movement from one vacant place to another causes anxiety, and it could lead to the possibility of failure. Mathematics should be shifted from hot afternoons to late evenings or rather in the morning time where by the memory of the examinees are still fresh to reduce tension and anxiety among the examinees.

- **Learners’ Efforts in Studying Mathematics**

The learners also attributed their poor performance in mathematics to lack of effort by some of them. The explanations given supporting this attribution included the following: Some learners are lazy, most learners are not able to answer past mathematics question(s) simply because they do not revise at all both at home or at school and some learners know that mathematics is difficult so they do not put any effort in it [8].

HOW I.T.S MODEL WORKS

I.T.S model typically have the following four components: The domain model, student model, learning model, and a learning environment (user interface).

The *domain model* is the area where the expert knowledge and behavior is located. The *student model* assesses the student's level of knowledge. This is where the AI (artificial intelligence) functioning of the system is essential so students are directed properly in their learning needs.

Different from other computer-based learning situations, the I.T.S uses highly *interactive* learning situations with simulations. The student's performance instructs the I.T.S, instruction is tailored for specific learning outcomes [8].

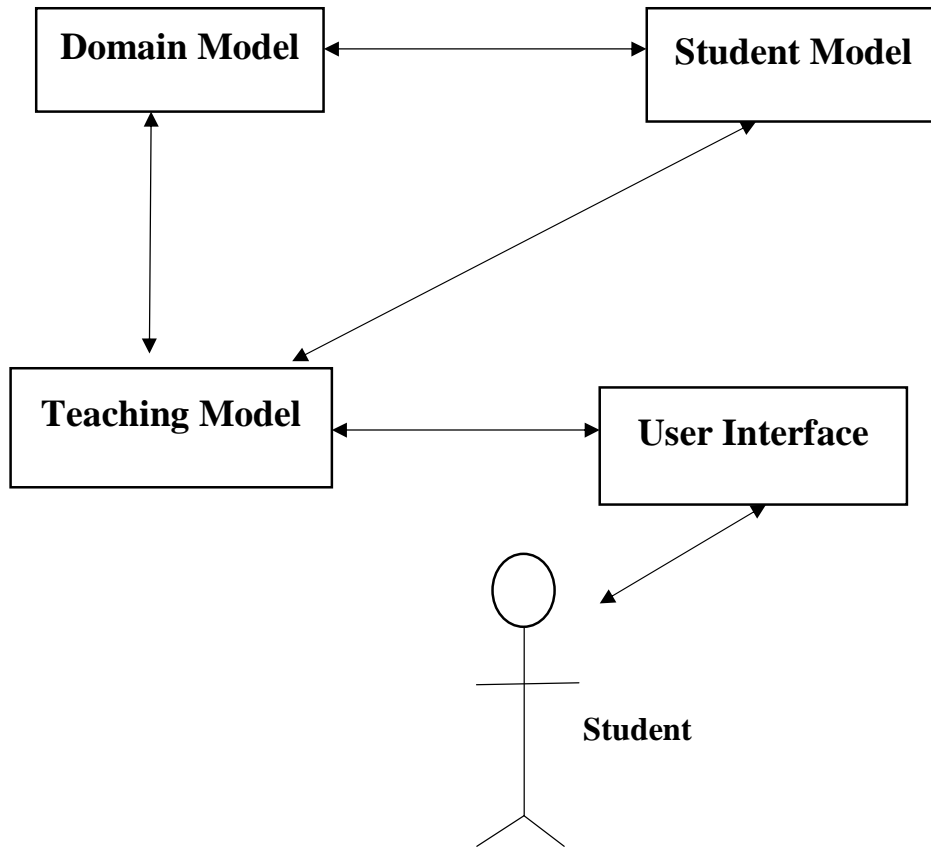
The pedagogical module or teaching model is the system's component that decides how and when the domain knowledge is presented to students. This module usually imitates the pedagogical approach used by human-tutors (e.g. when to present a new topic, which topic to present, when a review is needed) [11]. An I.T.S should have three tutoring characteristics [12]:

- Control over the representation of the pedagogical knowledge for selecting and sequencing the teaching materials;
- Capabilities for responding to a student's questions about pedagogical goals and content;
- Strategies for determining when a student needs help and for delivering the appropriate help.

Since the pedagogical module performs the same functions as a tutor in a one-to-one tutoring situation, then it interacts with the student by selecting problems to be solved, by monitoring and analyzing the student's performance, providing assistance upon a request, and selecting teaching materials that are necessary for addressing student's knowledge gaps. Teaching methods are determined on the basis of diagnostic information obtained in the student modeling process [13]. Considering the problem domain knowledge and student's current knowledge level, the pedagogical module selects the most effective way for the presentation of teaching material. By interacting with the student model, the pedagogical module decides which tutoring activities should be selected further so that the student could master the topic.

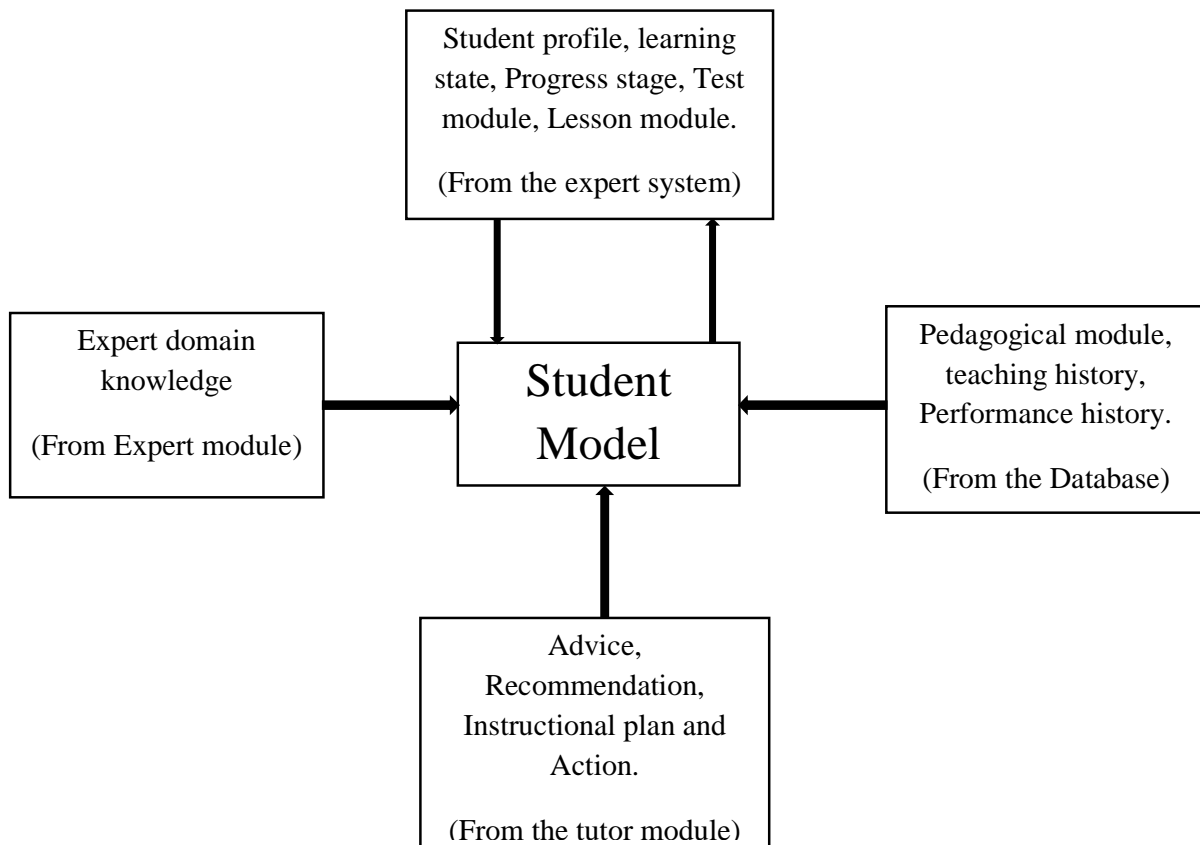
The pedagogical module should be designed in such a way that the appropriate teaching action is taken at appropriate time. For this purpose machine learning techniques, e.g. rule-based methods, Bayesian networks, or case-based reasoning are being used [14]. Once the appropriate tutoring strategy and the particular action are determined, they must be realized through the interface module. This module reflects the I.T.S in its final form – the way the student sees it.

The *interface model* controls interaction between the student and the system. The user interface can affect the success of the I.T.S because when the I.T.S presents a topic the interface can strengthen or weaken the presentation of teaching materials. Since the interface is the final form in which the ITS presents itself, qualities such as ease of use and attractiveness could be crucial to the student's acceptance of the system.



STUDENT MODEL

Student models could be classified by the nature and form of information contained in the model as well as the method of interpreting it. This proposal model can serve as the basis for classifying student models. In this context it is only necessary to point out that the proposed measurement breaks down into different generally independent trends: three criteria for classifying student models in accordance with the nature, form, and method of interpreting information contained in the models.



Structure of student Model

METHODOLOGY

RESEARCH TYPE

The study adopted descriptive survey type using frequency count and percentage for the analysis.

SAMPLING TECHNIQUE

The target population comprised of final year senior secondary schools student and few tertiary institution students. A total of 32 students were verbally interviewed and out of this 32 students, 13 out of them gave satisfied answers. These 13 were further given questionnaires and their response was used in the analysis of this research work.

RESEARCH INSTRUMENT

The questionnaire dealt mainly with students profile based on his/her opinion toward the improvement of teaching mathematics in secondary schools. The questionnaire consists of 13 questions. All 13 questions were filled with the response rate 100%, out of which 38% were females and 62% were males. The author used a sample of 13 students using stratified best sampling, who were also interviewed verbally among the 32. The reason for selecting these 13 students was because their response during the interview was impressive.

The main instrument used for this study was a research-designed questionnaire on students' views on how intelligent tutoring system (ITS) can be a tool in enhancing students' performances in mathematics. The questionnaire contained two (2) sections; section A sought information on personal data of the respondents and section B contains seven (10) probable on how intelligent tutoring can enhance students performances in mathematics. The response scales are: (Yes, No) (Very comfortable, comfortable, or uncomfortable)(Excellent, Very good, Good, or Poor) for the closed ended questions, and respondents were also required to air their opinions on the open ended questions provided.

RESULTS

This section presents the result of the data obtained from the respondents.



Question 1:What is your Gender? Male () Female ()

#	Answer	Response	%
1	Male	8	62%
2	Female	5	38%
	Total	13	100%

The majority of the respondents are males with a total of 8 responses while the female gender has a total of 5 responses out of the total 13 from the selected 32 who were interviewed, which may or may not have an impact on the way some questions were answered due to male


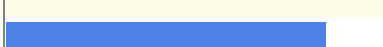
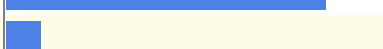
and female opinion on how intelligent tutoring system can enhance student performance in mathematics.

Question 2: State your age ___ Years

#	Answer		Response	%
1	16-20		7	54%
2	21-24		6	46%
	Total		13	100%

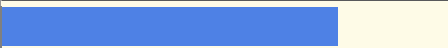

From the results shown above, it is clear that according to the total number of respondents which is 13, the age range between 16-20 got the highest number of response with a total of 7 which justifies that young adults within that age range are the most populated in the secondary school. They are closely followed by the age range 21-24 which are most likely from the tertiary institutions.

Question 3: How comfortable is your school learning environment?

#	Answer		Response	%
1	Very comfortable		2	15%
2	Comfortable		10	77%
3	Uncomfortable		1	8%
	Total		13	100%

According to the results, 77% of the respondents are comfortable with their school learning environment while 15% are very comfortable, and the remaining percent are not comfortable.

Question 4: Do you love mathematics?

#	Answer		Response	%
1	Yes		9	69%
2	No		4	31%
	Total		13	100%

It is clear that 69% of all the respondents answered Yes that they love mathematics and 31% of the respondent answered No, to the fact that they don't love mathematics.

Question 5: From question (4) above, state your reasons why you choose the option.

#	Answer	Response	%
1	Understand it well	8	61%
2	Don't understand the subject	1	8%
3	Complex & Difficult	4	31%
	Total	13	100%

From the results shown above, it is clear that according to the total number of respondents which is 13, 61% say they love mathematics because they understand it and they are good at it. 8% say the reason why they don't love mathematics is because they lack the understanding and the logic behind the subject. While 31% say mathematics is a difficult and complex subject so that is why they don't love the subject.

Question 6: Are the teachers of mathematics in your school adequately qualified and properly trained in the subject?

#	Answer	Response	%
1	Yes	10	77%
2	No	3	23%
	Total	13	100%

From the survey carried out, 10 out of 13 respondents are of the view that the teachers in their school are adequately qualified and properly trained in the subject. And 3 out of the 13 respondents are of the view that the teachers in their schools are not adequately trained and do not qualify to teach mathematics.

Question 7: How is Mathematics taught in your schools?

#	Answer	Response	%
1	Excellent	1	8%
2	Very Good	6	46%
3	Fair	6	46%
4	Poor	0	0%
	Total	13	100%

It is clear that a good number of these respondents are of the view that mathematics is well taught in their school, and 46% of the respondents believe the way mathematics is taught in their schools is very good and another 46% also believe that in their own school the way mathematics is taught is fair. Only 8% believe that mathematics is excellently taught in their school and none of the respondents said it was poorly taught.

Question 8: How comfortable are you taking mathematics lessons?

#	Answer	Response	%
1	Very comfortable	4	31%
2	Comfortable	6	46%
3	Uncomfortable	3	23%
	Total	13	100%

From the response of the above question it is clearly indicated that 31% of the respondents feel very comfortable during mathematics lesson, 46% show that they are comfortable and 23% show how uncomfortable they are during mathematics lessons.

Question 9: State the reason for your answer.

#	Answer	Response	%
1	Very comfortable	4	31%
2	Comfortable	6	46%
3	Uncomfortable	3	23%
	Total	13	100%

From the survey carried out, 31% who are comfortable during mathematics lessons stated the reasons why the love mathematics is because they enjoyed solving mathematics problems. Some also said they understand the subject because they found it easier to calculate than to write. Another reason was that mathematics helped their reasoning skills because it involved solving problems. 46% of the students that were comfortable during mathematics lesson said they needed to be comfortable with mathematics to pass their WAEC, NECO and JAMB examinations. Without mathematics, no student will be admitted into any tertiary institution as it is a requirement given by the NUC for every student to pass Mathematics and English on credit levels. The remaining 23% that were uncomfortable during mathematics lessons said they were afraid of the subject and found it difficult to understand, thus mathematics was very boring for them.

Question 10: Which topics do you enjoy in your mathematics class?

#	Answer	Response	%
1		5	38%
2		3	23%
3		1	30%
4		4	9%
		13	100%

There are some topics that attract audiences and encourage them to during mathematics, that is why 38% of the respondents stated that they enjoy all of their mathematics topics from SS1

– SS3, because they are confident while solving mathematical problems and also very comfortable because they are quick learners and they pick up fast during the learning process.

23% stated that they enjoy their SS1 topics and a few of their SS2 topics because at that level, the mathematical problems are more straight forward and easier to solve. Another 30% of the audience said that they only enjoy their SS1 and SS2 mathematics topics, and a few selected topics in SS3 that are more of continuation of their previous SS1 or SS2 topics. The remaining 9% stated that they only enjoy random topics in SS1-SS2 that present them with straight forward formulae to solve.

Question 11: Do you feel confident while solving mathematics problems?




#	Answer		Response	%
1	Yes		9	69%
2	No		4	31%
	Total		13	100%

Question 12: Do you think intelligent tutoring system (I.T.S) can enhance the performance of student in mathematics?

#	Answer		Response	%
1	Yes		10	77%
2	No		3	23%
	Total		13	100%

It is clearly stated from the above question that majority of the respondents believe that the implementation of intelligent tutoring system (ITS) in schools can greatly enhance the performance of students in mathematics. This will improve one-on-one effective tutoring, which will guide students through the learning process. It will provide immediate and specific instruction or feedback to students without the intervention of a human teacher. Also it will provide users, in this case students, with advice and recommendations for further work during a learning session.

Question 13: How do you think the study/teaching of mathematics can be improved if I.T.S is used?

#	Answer	Response	%
1		7	54%
2		4	31%
3		2	15%
	Total	13	100%

54% of these respondents suggested that teaching of mathematics in secondary school can be improved by providing students with a suitable learning environment. Some said the tutoring system should be provided for students in school so that they can involve themselves in one-on-one tutoring at their own leisure time without pressure. They also suggested that interactive mathematics learning tools should be provided to ease the learning process. 31% are of the opinion that qualified teachers who are specialized in such field should be employed to teach mathematics and not just those who think they are qualified. Mathematics teachers should be employed base on merit. The remaining 15% of the respondent are of the view that the students should have self-discipline to improve their learning skills. They concluded by saying that student should develop personal interest and the enthusiasm to understand the subject.

CONCLUSION

The findings of this study are in agreement with the findings of [8] that students mostly attribute their failure to external factors which cannot be controlled. The external factors include poorly qualified mathematics teachers and lack of resources. The students also attributed failure to themselves. The internal factors included negative attitudes towards the subject and absenteeism.

RECOMMENDATIONS

From the findings of this study, there is the need for the government to implement mathematical tutors (ITS) in all secondary school, because the implementation of this intelligent tutoring system will help the secondary school student to effectively learn mathematics at their leisure time. There are several advantages in learning with intelligent tutoring system (ITS) over the traditional approach to teaching/learning mathematics. If (ITS) is implemented in schools, students will be with the system ability to provide them with many useful information, feedback messages and advices for further work during the learning session. There is also the need to improve the quality of mathematics learning tools. Teachers should be in-serviced in the use of student-centred teaching methods that are appropriate and that make the learning of mathematics interesting. Teachers should embark on team-teaching in order to make mathematics teaching/learning more enjoyable for students.

REFERENCES

- [1] Betiku, O. F. (2001). Causes of Mass Failures in Mathematics Examination among Students a Commissioned Paper presented at Government Secondary School. Karu Abuja ScienceDay 1st March.
- [2] Sells, M. O. (1978). Mathematics a Critical filter. *Science Teachers Association* 45 (2) 28-29.
- [3] Ojo, J. O. (1986). Improving Mathematics Teaching in our Schools, *ABACUS. Journal Mathematics Association of Nigeria* 17(1) 164-177.
- [4] Ale, S.O. (1989). *Combating Poor Achievement in Mathematics ABACUS*. The Journal of the Mathematics Association of Nigeria 19 (1)
- [5] Ajagun, G.A. (2000). A study of the performance of students in the senior secondary school certificate examination in selected schools in Kano State. Tambori: Kano Journal of Mathematics Association of Nigeria 19 (1). *Education* 6 (1): 10-21.
- [6] Ojerinde, D. (1998). Under Achievement in School Science in Nigeria: The way out. *African Journal of Education* 1(1): 76-191.
- [7] Nnaka, C.U. & Anaekwe, M.C. (2004). Application of Research Findings in Science, Technology and Mathematics (STM) Education to enhance Classroom instruction: the place of Cooperative Learning strategy. Science Teachers' Association of Nigeria Proceedings of the 45th Annual conference.
- [8] S.A. Tachie and R. Chireshe. (2013). High Failure Rate in Mathematics Examinations in Rural Senior Secondary Schools in Mthatha District, Eastern Cape: Learners' Attributions. *Stud Tribes Tribals*, 11(1): 67-73 (2013).
- [9] Hassana Oseiwu Ali (2013): *Factors Affecting Students' Academic Performance in Mathematical Sciences Department in Tertiary Institutions in Nigeria*. *US-China Education Review A*, ISSN 2161-623X, December 2013, Vol. 3, No. 12, 905-913.
- [10] Tracey Best and Shelby Budd (2007), revised by Paul Darvasi (2008), also revised by Bridget Perry-Gore (2011). 'Intelligent tutoring system'.
- [11] Kort, B.; Reilly, R.; Picard, R. W. 2001. An affective model of interplay between emotions and learning: reenginee-ring educational pedagogy-building a learning companion, in Proceedings of

International Conference on Advanced Learning Technologies, 6–8 August, 2001, Madison, Wisconsin, 43–48. <http://dx.doi.org/10.1109/ICALT.2001.943850>.

- [12] Bhagat, S.; Bhagat, L.; Kavalan, J.; Sasikumar, M. 2002. Acharya: an intelligent tutoring environment for learning SQL, in Proceedings of the Vidyakash 2002 International Conference on Online Learning, 15–17 December, 2002, Mumbai, India, 1–11.
- [13] Ally, M. 2005. Intelligent tutoring systems for distributed learning, in Designing distributed environments with intelligent software agents, 162–183.
- [14] Sarma, S. B. H. 2007. Intelligent tutoring systems using reinforcement learning. Department of Computer Science and Engineering, Indian Institute of Technology Madras. 43 p.