A comparative study between Animated Intelligent Tutoring System (AITS) and Video-based Intelligent Tutoring System (VITS)

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ملخص البحث

في عصر تكنولوجيا المعلومات، الحركة و مقاطع الفيديو و الوسائط المتعددة غيرت الـدور التقليـدي للمدرس و للمتعلم. أشارت دراسة سابقه أن استخدام البرامج الذكية حسنت أداء الطلبة الضعفاء [1].

يهدف هذه البحث إلي دراسة مدي تأثير برامج التدريب الذكية بواسطة الحركة و برامج التدريب الذكية بواسطة مقاطع الفيديو على أداء الطلبة في مادة البيولوجي في المستوي الأول في جامعـة الأزهـر بغـزة. تشير نتائج هذا البحث إلي أفضلية استخدام برنامج التدريب الذكية بواسطة مقاطع الفيديـو مقارنـة مـع كـل من برنامج التدريب الذكيـة بواسطة الحركـة و الطريقـة التقليديـة وتشـير النتـائج أيضـا إلي فعاليـة برامـج التدريب الذكية في تحسين أداء الطلاب في الاختبارات ولم تظهر الدراسة أي اثر للجنس أو للمـدرس علـي اسـتعمال برامـج التدريـب الذكيـة كمـا تشـير النتـائج إلي وجـود علاقـة موجبـة قويـة بـين أداء الطلبـة في الاختبارات و تقيم الطلبة لبرامج التدريب الذكية.

Abstract

In today's Information Technology (IT) age, animation, video, and multimedia courseware are changing the traditional role of teachers and learners. It has already been shown that ITS can be used as an effective tool for improving the slow learners performance [1]. This paper investigates the effect of using Animated Intelligent Tutoring Systems and Video-based Intelligent Tutoring Systems on the performance of first year biology students in Al-Azhar University, Gaza. The results indicated that there is an advantage of using Video-based Intelligent Tutoring Systems over Animated Intelligent Tutoring Systems and traditional method of teaching. Furthermore, the study indicated that ITS improved the performance of students in biology exams. Also, sex and instructors were not found effective factors in the use of ITS programs. The study showed a strong relationship between student performance in exams and student evaluation of ITS programs.

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Introduction

The Animated Intelligent Tutoring System (AITS) and Video-based Intelligent Tutoring System (VITS) are intelligent tutoring systems developed as a teaching aid for a course on biology for freshman students in Al-Azhar University in Gaza to enhance students' understanding of biology including lab experiments. A previous study was carried out on a 10^{th} grade biology students in secondary schools in Gaza using Intelligent Computer Aided Instructions (ICAI) [1]. AITS has the capability to display simulated lab experiments graphically on the computer screen as well as allowing graphical manipulation of the experiments created. VITS has the capability to play video-clips of how experiments are done instead of animating the experiments. There is a tutorial mode incorporating exercises, where students can learn how experiments are done visually.

The traditional role of teachers and learners connotes an active teacher/passive student relationship, usually with the teacher lecturing at the front of the class while students sit at desks in rows and listen, take notes, and occasionally ask questions. The knowledge obtained is then applied to practical exercises in a supervised laboratory session, generally of one-hour

duration. Students have to complete their experiments within the session.

With the maturing of the Information Technology (IT) age, multimedia courseware has increasingly emerged, especially in the last decade. It has been shown that multimedia helps to make education more attractive and hence more effective by providing higher levels of interactivity [2,7]. In science education, the visualization and interactive animation of experiments has a positive effect on learning and is regarded as attractive by students [3,8,9].

The Intelligent Tutoring System

Program Design

AITS and VITS are identical systems except for one feature. The first system uses Animation for demonstrating simulated experiments and the later uses video-clips to demonstrate the experiments. Both intelligent Tutoring systems are completely implemented using Macro-Media Flash 4. The system consists of several core models, which are relatively independent of each other to allow easy upgradability and portability to other teaching domains:

1. A *Student Model*, which will monitor the progress of the student.

2. An *Expert Model*, which stores instructions for each exercise as well as the initial state (if any). This model also provides the template by which to compare student actions, to detect constraint violations made by the student.
3. An *Expert Tutor*, which operates on the Student and Expert Models. It is responsible for the validation of each move by the student in an exercise (by means of pattern matching the corresponding steps from both models). The tutor uses the constraint based tutoring module as proposed by [4] and described in detail in [5,6].
4. The *Graphical User Interface (GUI) Shell* which serves as the bridge or HCI interpreter between students and the ITS [6].

Every user has one copy of the Expert and Student model in the Expert's Knowledge Database. AITS contains one semester of exercises for the Biology course in the first year university. In order to provide an interactive environment suitable for detailed simulations of physical phenomena, the AITS has been developed using Macro-Media Flash 4. The interface makes full use of high-resolution graphics, color and sound to deliver a sophisticated real-time simulation as a mean

of enhancing the students' ability to relate the tutorial environment to that of the laboratory and the "real world". A robust strategy (adapted, in part, from the LISP Tutor [6]) of examining user input continuously and providing immediate feedback upon detecting errors is utilized. The AITS is not intended to replace a human instructor or to replace the existing program of biology instruction. Instead, the ITSs that we are developing will provide an interactive environment for the application of biology concepts to the solution of problems. The principal goal of the ITS is to enable the average student to efficiently acquire the problem solving skills necessary for successful mastery of first year university biology. It is anticipated that a large fraction of such biology classes could be served by the ITS, freeing the human instructor to work more closely with the slower students as well as with the more advanced students. The tutorial lessons are integrated with the lecture/laboratory portions of the typical course, and students will have independent access to the ITS for completion of their homework.

Since the intent of the ITS is to complement an existing textbook and course in which concepts will be logically introduced, it is essential that ITS be adaptable to a variety of texts.

For each ITS lesson the student progresses from easy problems to harder ones; furthermore, ITS includes problems in which the student must be given the required item(s), obtain the necessary data through the observation of an animated simulation or video-segment simulation.

In the "text-only" problems, the student in initial tutoring sessions is provided with a structured environment within which to solve the problem. The listing of given information and the identification of the required item(s) can be enforced by the ITS. Further, the available data for obtaining the required result(s) from the given information are obtained through menu and button interactions. At the top of the window is a region that provides the problem description to the student (in the form of text or mixed text and graphics). At any time during the interaction, the ITS can intervene by "popping-up" a window and/or providing audible feedback. In addition, the student can obtain assistance (examples, hints, etc.) by using the contextually sensitive help function.

Advanced exercises have been developed in which the tutor can lead the student in abstracting real-world problems in a manner that facilitates their solution via sound effects, animation, and video-clips. Experience has shown that most students have great difficulty in reading text describing a

problem and producing an abstract representation of the problem that fits the problem solving patterns they have been shown by an instructor or in a textbook.

Error detection and remediation occur at a local level with each student action compared to expected correct and incorrect actions. Based on the nature of each student error, appropriate feedback is given to enable the student to understand and correct his or her error. A global ITS strategy draws on a student model which identifies lacks of skills and knowledge demonstrated by the student in attempting to solve problems within the ITS environment. The number, type, and order of the exercises encountered by the student is determined by heuristic rules which examine the student model and the performance of the student on the exercises completed in the current lesson. The student model is also used to determine the way in which assistance is provided to the student. That is, the type, length, and tenor of messages can be tailored to the student based on the history of their experience with the tutor as contained in the student model.

Purpose of the study

The purpose of this study is to investigate the effectiveness of using different programs of ITS in simulating lab experiments in first year university biology course. The study evaluates the

1. There are no significant differences in performance between students taught using the conventional method and students taught using the ITS programs.
2. There are no significant differences in performance between students (males and females) in animated ITS program. There are no significant differences in performance between students (males and females) in video-based ITS program.
3. There are no significant differences in performance between students taught using Animated ITS and Video-based ITS program.
4. Students' evaluation of the benefits of using ITS programs is strongly positive.
5. There is a strong positive relationship between students' performance in ITS groups and their evaluation of the benefits of using ITS.
6. There are no significant differences in students' performance in ITS groups according to instructor.
7. There are no significant differences in students (males and females) evaluation for the benefits of ITS in Video-based ITS according to sex.

8. There are no significant differences in students' (males and females) evaluation for the benefits of ITS in Animated ITS group according to sex.

Research Frame:

The research was conducted on freshman students in Al-Azhar University, Gaza, in biology only.

Sample:

In the period from 1/10/1999 to 1/7/2000, 420 students were randomly chosen from Al-Azhar University in Gaza. All students were freshman students with no previous exposure to computers except for the computer course given to them in high school (DOS and windows). The students had no prior knowledge in the subject matter to be taught.

Procedure and data collection:

The (420) students were randomly assigned to 3 groups :

Group 1(the control group):

This group was taught using the conventional teaching method (lecture and textbook). This group consists of 140 students (70 males and 70 females).

Group 2(the AITS group):

This group was taught using the Animated Intelligent Tutoring System version of the program. This group consists of 4 instructors and 140 students (80 males and 60 females).

effect of some factors related to ITS and students evaluation of the benefits of using ITS programs.

Questions of the study:

1. Are there significant differences in performance between students taught using the conventional method and students taught using ITS?
2. Are there significant differences in performance between students taught using Animated ITS and Video-based ITS form?
3. Are there significant differences in students evaluation of the benefits of using ITS programs according to sex in any of the ITS groups?
4. What are students evaluation of the benefits of using ITS ?
5. Is there a relationship between students' performance in ITS groups and their evaluation of the benefits of using ITS ?
6. Are there significant differences in students' performance in the groups of ITS according to instructor?

Hypothesis:

Group 3(the VITS group):

This group was taught using the Video-based Intelligent Tutoring System version of the program. This group consists of 3 instructors and 140 students (70 males and 70 females).

All groups were given a questionnaire for the benefits of using Intelligent Tutoring System (see appendix A).

At the end of instruction all students were given an exam in the subject matter studied, and their exam grades were recorded. These grades are to be used to examine possible differences in performance between those groups.

Statistical analysis:

1. A one–way ANOVA test was conducted on the grades of the exam for students in groups: 1, 2, and 3. To determine if there were any significant differences in students performance between the conventional group and the ITS groups. This test was conducted on the entire sample (420 students). If significant differences are to be found, the Scheffe multiple comparison test is to be used to determine differences between group pairs and to investigate possible advantages of one group over another.

2. An independent-sample-t test was conducted on the exam grades for male and female students in ITS groups (2,3) one group at a time, to determine if significant differences in performance exist between male and female students in each ITS group. The same test was performed on the student evaluation scores to determine if significant differences in performance exist between male and female students in evaluation of each ITS group.
3. For each ITS group (2, 3), the correlation coefficient for students evaluation of the benefits of using ITS and their performance was computed. The average of total score of students for each group (2,3) is computed to determine the degree of students' evaluation.
4. A one–way ANOVA test was conducted on the exam grades of students in ITS group (2) to determine if there exist an instructor effect on students performance or not.
5. An independent-sample-t test was conducted on the exam grades of students in ITS group (3) to determine if there exists an instructor effect on students' performance or not. The statistical analysis was performed using SPSS 9.

Results and discussion:

1. Table (1) shows the results of the ANOVA test for the conventional (control) group and ITS groups. The table shows that there are significant differences between the groups.

Source of Variation	Sum of Squares	Df	Mean Square	F	Significance
Between groups	35.371	2	17.841	29.841	Significant(*)
Within groups	247.143	417	.593		
Total	282.514	419			

Table (1) ANOVA table for the exam grades for groups (1,2,3).

* Significant at the (0.05) level.

2. Table (2) shows the results of Scheffe multiple comparisons between group pairs. It can be seen from table (2) that there are significant differences in performance between the 3 groups in favor of: first of all VITS group, secondly AITS group, and at last the conventional group. That indicate the followings:

- Advanced ITS programs are better than the conventional methods.
- VITS program is better than AITS program.
- Students prefer demonstration type of programs over animation programs.

Group(I)	group(j)	Mean Difference (i-j)	Significance
G1	G2	-.46*	Significant(*)
	G3	-.70*	Significant(*)
G2	G1	.46*	Significant(*)
	G3	-.24*	Significant(*)
G3	G1	.70*	Significant(*)
	G2	.24*	Significant(*)

Table (2). Scheffe multiple comparisons between group pairs

* The mean difference is significant at the 0.05 level.

3. Table(3) shows the results of the independent samples–t-test between male and female students in the AITS and VITS groups. The results show that: there are no significant differences in performance between male and female students in any of the ITS groups. This indicates that ITS programs are stable and can be implemented effectively.

Group	Sex	Mean	Std. Deviation	T	df	Significance
G2	Male	5.87	.93	-1.063	138	(not Significant)
	Female	6.03	.83			
G3	Male	6.17	.45	.000	138	(not Significant)
	Female	6.20	.75			

Table (3) the independent samples t-test results for male and female students exam grades in ITS groups.

4. Table (4) shows the results of the independent samples–t-test of students' evaluation scores to determine if significant differences in performance exist between male and female students in evaluation of each ITS group. The results show that: there are no significant differences in students' evaluation of ITS groups between male and female students. This indicates that ITS programs are stable and can be implemented effectively.

5.

Group	Sex	Mean	Std. Deviation	T	df	Significance
G2	Male	78.33	14.11	.817	138	(not Significant)
	Female	76.87	6.48			

G3	Male	73.20	6.90	- 1.684	13 8	(not Significant)
	Femal e	74.80	3.95			

Table (4) the independent samples t-test results for male and female students' evaluation scores of ITS groups.

6. Table (5) shows the results of students' evaluation of the benefits of using ITS groups (2,3). The questionnaire (see appendix A) consists of 18 paragraph and each paragraph has 5 possible choices ranging from strongly disagree (weight 1) to strongly agree (weight 5). The maximum value for a questionnaire is 90 (18 x 5), the average value is 54 (18 x 3), and the minimum value is 18(18 x 1). Table (5) shows the mean values for both male and female students out of the possible value 90. The same table shows the mean values out of 100%. The total average of male and female students in AITS group is %86.11 with %87.03 and %87.41 for male and female students respectively. Furthermore, the total average of male and female students in VITS group is 74.00% with 73.20% and 74.80% for male and female students respectively. The result indicates that students' evaluation of the benefits of using ITS programs is strongly positive.

Group	Sex	Mean	Std. Deviation	Positive Mean ÷ 90 x 100
G2	Male	78.33	14.11	%87.03 (positive)
	Female	76.87	6.48	%87.41 (positive)
	Total	77.50	10.43	%86.11 (positive)
G3	Male	73.20	6.95	%81.33 (positive)
	Female	74.80	3.98	%83.11 (positive)
	Total	74.00	5.66	%82.22 (positive)

Table (5) the independent samples t-test results for benefits of male and Female students using ITS..

7. Table (6) shows the correlation coefficients between students' performance in ITS groups (2,3) and their evaluation of the benefits of using ITS. These results show a strong positive relationship between the performance of students and their evaluation of the benefits of using ITS.

Group	Exam Grade
G2	0.540(*)
G3	0.266(*)

Table (6). Correlation between student evaluation of the benefits of using ITS and their performance.

* Correlation is significant at the 0.01 level.

8. A one–way ANOVA test was conducted on the exam grades of students in group (2) to determine if there exist an instructor effect on students performance or not. Table (7) shows that there are no significant differences in students' performance according to instructors. This indicates that ITS programs can be used with many different instructors without losing any advantages of ITS programs.

Source of Variation	Sum of Squares	df	Mean Square	F	Significance
Between groups	2.110	2	1.055	1.349	.251 not significant(*)
Within groups	103.633	137	.756		
Total	105.743	139			

Table (7) ANOVA table for the exam grades for group(2) according to instructors.

*Significant at the (0.01) level.

9. An independent-sample-t test was conducted on the exam grades of students in ITS group (3) to determine if there exists an instructor effect on students' performance. Table (8) shows that there are no significant differences in students' performance according to instructors. This indicates that ITS programs can be adapted with many different instructors without losing the benefits of ITS programs.

Instructor	**Mean**	**Std. Deviation**	**T**	**df**	**Significance**
3	6.175	.46	-.272	138	not significant
4	6.210	.75	-.272	112.572	not significant

Table (8) the independent samples t-test results for exam grades for group(3) according to instructors.

Conclusion:

In this paper, we presented an Animated Intelligent Tutoring System called (AITS), a Video-based Intelligent Tutoring System called (VITS), and an evaluation study of both systems. The results of this study suggest that AITS and VITS can be used as an effective teaching method, however, that does not mean those AITS nor VITS can replace human instructors. Intelligent Tutoring Systems can be effective only under the supervision of a human instructor. The study also shows that the performance level of students (males and females) in Video-based Intelligent Tutoring System is improved more than the performance level of students (males and females) in Animated Intelligent Tutoring System.

Also, the study has shown that sex and teacher are not factors affecting the use of the ITS programs. Finally, the results suggest that the performance of students taught using ITS is strongly related to their evaluation of the benefits of using ITS.

Recommendations:

Further research is needed in the possible use of other (ITS) models, because ITS proved to be an effective tool for aiding students in their study at the university level. We recommend that ITS should be designed with both animation and video-clips because student like to see, modify, and try lab experiment using animation. Furthermore, students do not like

to read written text all the time. ITS with video-based helps students in explanation of lessons and experiments. Instructors must be given a thorough training in the design and implementation of ITS programs, which will enable them to produce their own ITS teaching material.

Appendix A

الاستبيان

الجنس : [ ] ذكر [ ]أنثى

رقم المدرس :_____

م	العبارات	موافق جداً	موافق	لا أستطيع التحديد	غير موافق	غير موافق إطلاقاً
1	ساعدني البرنامج على التعلم					
2	استخدام البرامج التعليمية يساعدني على الدراسة بشكل أفضل					
3	استخدام البرامج التعليمية يساعدني على الحصول على درجات افضل					
4	استخدام البرامج التعليمية يوفر على					

م	العبارات	موافق جدا	موافق	لا أستطيع التحديد	غير موافق	غير موافق إطلاقا
	الوقت و الجهد					
5	استخدام البرامج التعليمية كأداة مساعدة في الدراسة مفيد جداً لدراسة جميع المواد					
6	استخدام البرامج التعليمية في المواد التي ندرسها سيحسن حياتي اليومية					
7	من المهم تعلم استخدام البرامج التعليمية في الدراسة					
8	سأحتاج البرامج التعليمية في دراستي في المستقبل					
9	تساعدني البرامج التعليمية في تنظيم دراستي					
10	استخدامي للبرنامج التعليمي في دراسة الدروس العلمية جعلني أشعر بالراحة أكثر في دراستي					
11	استخدامي للبرنامج التعليمي أعطاني صورة أوضح عن الحقائق و الصور و الأشكال					

م	العبارات	موافق جدا	موافق	لا أستطيع التحديد	غير موافق	غير موافق إطلاقا
12	استخدامي للبرنامج جعلني أفهم التجارب العلمية بشكل أفضل					
13	استخدام البرنامج التعليمي جعلني أعمل التجربة بثقة أكبر					
14	لم أواجه أي صعوبة في أداء التجربة بعد استخدام البرنامج التعليمي					
15	استخدام البرنامج التعليمي جعلني أحب مادة البيولوجي					
16	شرح البرنامج للتجارب أفضل من شرح الكتاب لها					
17	شرح البرنامج للتجارب أفضل من شرح المدرس لها					
18	أتمني أن تستخدم البرامج التعليمية في شرح التجارب العلمية في باقي المواد					

$\alpha = 0.91$

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