Assessing the effects of tutorial and edutainment software programs on students' achievements, misconceptions and attitudes towards biology

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Abstract

The purpose of this study was to investigate the effects of tutorial and edutainment software programs related to ''genetic concepts'' topic on student achievements, misconceptions and attitudes. An experimental research design including the genetic concepts achievement test (GAT), the genetic concept test (GCT) and biology attitude scale (BAS) was applied at the beginning and at the end of the research. After the treatment, general achievement in GAT increased in favor of experimental groups. It was also noticed that using edutainment software programs significantly changed students' attitudes towards biology. However, only tutorial design software program had the positive effect to the awareness of students' understandings to the concepts gene, DNA, nucleus, chromosome, allele, genetic information, and genetic code. The current study also revealed that there were still some misconceptions in the experimental groups even after the treatment.

Key words: Computer assisted instruction, Instructional software, Evaluation of educational technology, Secondary education

Introduction

In the last decade, many researchers have shown that students have serious misunderstandings about genetics, even after instruction, concerning the basic scientific content related to biological inheritance (Banet and Ayuso, 2000; Yip, 1998). Students face problems in representing genetics texts into schemes and symbols, and vice versa in reading schemes and symbols. Knowledge of the extensive genetic terminology is required to understand a classical genetics. However, students are often not familiar with the definitions of the genetics related terms, and they may get confused because terms look and sound very similar, e.g. homologue, homologous, homozygous and homozygote (Bahar *et al*, 1999). Besides, students face problems due to misuse of genetic terms, the existence of synonyms and the occurrence of redundant and obsolete terminology (Saka et al., 2006). Because of the importance and the difficulty of the subject, science teachers seek for effective teaching approaches in their teaching.

Common teaching methods used in biology education

One of the common teaching methods that biology teachers prefer today is the lecture method. In this the teacher transmits knowledge to the students who sit passively in the classroom and listen. Another common method is the question-and-answer approach, which was developed in order to avoid the boredom caused by lectures and to provide a more efficient learning environment. On the other hand, case studies allow the students to face the problems that occur in real life. They help to fill the gap between theory and practice through putting the previously learnt concepts and principles into use. The best part of this method is that it enables the students to apply what they have learnt to what they are living through (Sönmez, 1986). A useful part of instruction in biology is the performing of experiments. This can be done by demonstrations when the teacher actively carries out the experiments in front of the class or demonstrates some materials (Bayramlı, 2000) or by the students who learn about a subject by carrying out experiments in the laboratory or classroom, in which case the role of the teacher is to guide and help them where necessary.

CAI and biology education

In contrast to the previously described methods, in *Computer-Assisted Instruction* (CAI), the teacher can use computers at different times and places according to the characteristics of the subject matter, the students, and the available software and hardware. Computerized learning environments offer several facilities that can be used to improve the teaching of biologic processes. A computer enables repeated trials of an experiment with considerable ease in a limited time, provides immediate feedback, allows simultaneous observation of graphical representations, and offers a flexible environment that enables students to proceed with their own plans (Fisher, 1997; Mintz, 1993; Plomp and Voogt, 1995). None of these features are easily available in a didactic classroom situation in which the teachers deliver informational programs with little or no interaction.

Major classifications of CAI

The major classifications of CAI lessons include tutorials, drill and practice, simulations, and instructional games (Alessi & Trolip, 1985). A number of other classifications, such as problem-solving and inquiry lesson designs have been discussed, but the overwhelming majority of CAI lessons fall within the previous four classifications. Each basic design provides a unique method for using the computer to teach, reinforce, practice, or apply information. In many cases, various design

combinations, called hybrid designs, are developed to utilize the advantages and, in some cases, to minimize the disadvantages, of each design option.

In tutorials, information is taught, verified, and reinforced through interaction with the computer. Tutorials are generally used to present new information to learners, particular skills, information, or concepts. In many cases, the instruction is designed to be self-contained, that is, the teaching and learning of all relevant information are accomplished within the lesson. Students are typically questioned during the tutorial to verify comprehension. Lesson information may be further reinforced using computer-based or traditional teaching systems, but tutorials should teach well-defined objectives thoroughly enough to eliminate the need for repetition through another teaching system (Bramble & Mason, 1985; Hannafin & Peck, 1988).

With the latest advancement in computer science and technology, edutainment is being increasingly recognized as a technology for fundamental learning (Cai et al, 2006). "Edutainment software", is a hybrid genre that relies heavily on visual material, on narrative or game-like formats, and on more informal, less didactic styles of address (Okan, 2003). The purpose of edutainment is to attract and hold the attention of the learners by engaging their emotions through a computer monitor full of vividly colored animations. It involves an interactive pedagogy and totally depends on an obsessive insistence that learning is inevitably fun (Ito, 2006).

CAI is defined as any program that augments, teaches, or simulates the learning environment used in the traditional classroom (Quyang, 1993), including Web-based instruction, self-running simulations, drill-and-practice programs, and multimedia classrooms (Murphy et al., 2002). Tutorial and edutainment software programs are forms of CAI that have the following additional attributes: motivation, reward (feedback), interactivity, score, and challenge. However, it remains unclear as to whether or not learning through tutorial and edutainment instructional software programs will improve upon traditional teaching results.

The Purpose of the Study

The purpose of this study was to assess the effects of the tutorial and the edutainment instructional software programs on students' misconceptions, achievements and attitudes towards biology.

Methodology

Sample

The sample consisted of 72 students (age range 14–15 years) enrolled in three ninth grade classes of a public secondary school that is well known for its high standards. The study used intact classes, and the students were equally distributed across the three ninth-grade classes that took part in the study. Randomly, one of the classes (n = 24) received the tutorial software program used computer-assisted instruction and the other class received the edutainment software program used (n = 24) computer-assisted instruction while the last class (n = 24) received regular instruction.

Research Design

A pretest–posttest control-group experimental research design was used in this research. The participants in three groups were tested before and after a 2-week intervention. The experimental groups' students were taught by the computer-assisted instruction, whereas the comparison group students received regular instruction. All of the groups received an equal amount of instructional time and were taught the same instructional content. The instruction for the three study groups took place during the same week by the same teacher (one of the researchers) and lasted for a period of two class-hours (45 min each).

Instrumentation

The genetic concepts achievement test, the genetic concepts concept test and the biology attitude scale were used in the study.

Genetic concepts achievement test

To measure students' achievement on the issue of genetic concepts, a genetic concepts achievement test (GAT) was developed by the authors of this study and its content validity and reliability were checked by applying guidelines described previously (Davis, 1988; Haladyna, 1994). The test content and objectives were determined according to the Ministry of National Education's High School Biology Curriculum. The GAT items were selected from the textbooks and preparation books written for the University Entrance Examination. There were 24 multiple choices type items in

the test (see sample questions in Appendix A). The items were based on the following categories: The chemical structure of nucleotides and nucleic acids, and their importance for life, the molecular structure of genes, chromosome theories (gene, allele gene and chromosome), genetic code, genetic information, variation and its environmental and genetic causes, the transfer of information between generations. The reliability of the test (r=0.75) was determined by using the Cronbach's alpha.

Genetic concepts concept test

A written test was designed to ascertain students' misconceptions about genetic concepts. The genetic concepts concept test (GCT) was modified on the basis of review of related literature (Lewis *et al*, 2000; Lewis & Wood-Robinson, 2000). The set of questions was designed to probe the students' general understanding of the terms gene, DNA, nucleus, chromosome, allele, genetic information, and genetic code. There were fourteen open ended questions including the questions about genetic concepts ideas relating to location and function (see Appendix B).

Individual written responses to the series of written questions were coded according to the coding schemes which were based on students' own responses, and developed through an iterative process of reconsideration. In this way, all responses were categorized in order to make a more detailed comparison into the students' understanding of genetic concepts. Also, the number of students who gave scientifically correct answers was noted. By using the numbers of correct-wrong answers as the data, the Cronbach's alpha reliability coefficient was found to be 0.88.

Biology attitude scale

Canpolat's (2002) attitudes scale was adapted as biology attitude scale (BAS) in this study to assess the sample's attitudes towards science lessons. 15 sentences occurring in a Likert-type scale and with five alternatives were given students to determine their ideas about the biology lesson (see Appendix C). In these sentences there were positive and negative statements. In the scale, positive statements were scored as 1, 2, 3, 4, and 5 according to its grade. Negative statements were scored as 1, 2, 3, 4, and 5 according to its grade. BAS was given at the beginning and end of the implementation to the three groups. The internal consistency reliability of the scale was found to be 0.853.

Instructional Materials

Instructional Software Programs

The method of selecting the software to be evaluated was determined by the following characteristics. It had to be among the published instructional software programs for computer assisted biology education in secondary schools in Turkey, developed at 9th grade level, and was produced in 2000 or later. Among the pieces of instructional software programs fit the above criteria *Rediscover Science and Math*(Edunetics Inc.) was selected as tutorial software program and *Bioscopia* (SEBIT Education and Information Technologies Inc.) was selected as edutainment software program. Both of the instructional software programs covered several different subject areas, but the only portion of the software evaluated for this study was the genetic concepts. A brief description of the two programs is given below.

"*Rediscover Science and Math*" is a computer program which addresses higher order, creative and critical thinking and it helps to make connections to all content areas. The biology content of the material is arranged around three CD-ROM; 9th grade, 10th grade, and 11th grade. Each unit is further divided into a number of sections, for example, the 9th grade topic covers cell biology, life in ecosystem, and genetic according to the Turkish national biology curriculum. Having selected a section, the student finally accesses information by choosing subsections from them. As an example, the genetic section deals with the DNA, double helix, genetic code, and inheritance. Each unit comprises text, animations, audio commentary, photos, diagrams, and learning activities with feedback. Each activity within a topic takes one classroom period to complete.

Bioscopia is a role-playing science adventure game. The student's mission is to rescue a young scientist. To complete the mission and escape from *Bioscopia*, students have to learn about biology and apply that knowledge to solve *Bioscopia*'s clever puzzles. Students must search the disabled, abandoned laboratories, solve biology puzzles and eventually create the antibiotic that will ultimately save the biologist. Student will need knowledge of Genetics, Human and Cell Biology, Botany and Zoology to solve the puzzles and unlock doors that will lead the student to be a young scientist. It's not that the puzzles themselves are that hard to solve; there is help available in the science tutor (Big Brain) that features all the answers to the questions and is a presentation of hundreds of fascinating facts and concepts of the biology.

Procedure

The study was conducted during the second term of 2005–2006 academic years, when "genetic concepts" was being covered as part of the regular school curriculum. The three instruments (GAT, GCT, and BAS) were administered to the students 2 weeks before the treatment commenced as pre-tests. It took 45 minutes for the subjects to respond to the instruments. The instruction for the three study groups took place during the same weeks by the same teacher (one of the researchers). The treatment lasted for a period of four class-hours (45 min each). The three instruments were re-administered to the subjects as post-tests 2 weeks after the treatment ended.

Computer Assisted Instruction Group

Experimental groups had their instruction in the computer laboratory. All the students were computer literate, since they took computer courses as part of the school's regular curriculum. Since instructional software programs were new for the students, before the treatment students in the experimental groups were trained about the usage of instructional software programs. The students in experimental groups worked individually in a computer lab without any guidance or help from the instructor who was also the researcher. "Rediscover Science and Math" software program was used in the first experimental group (EG1), while the "Bioscopia" software was used in the second experimental group (EG2). Students in EG1 and EG2 followed the instructional program as projected to a screen from the teacher's personal computer as well as their own computers. The teacher made a brief introduction about the subject that going to be learned and simply presented the contents of the lecture. Then, the students were left to work alone, with minimal interference from the teacher who was present only to respond to questions raised by individual students.

Regular Instruction Group

The control group (CG) was given a traditionally designed instruction, which is a dominant approach in contemporary Turkish Educational System. In the CG, the teacher-directed strategy was used as traditional instruction. The teacher used lecture and discussion methods to teach cell division. The students were required to read the related topic of the lesson from the textbook before lecture. The teacher described and defined the issues and afterward, students were engaged to discussion through teacher-directed questions. The major part of instruction time (70–80%) was devoted

to instruction and engaging in discussions stemming from the teacher's explanation and questions.

Data Analysis

One-way ANOVA was used to elicit whether there was a significant difference among groups for the GAT, GCT and BAS. Significance level was decided by taking p values into consideration $p>0.05$, meant there was not a meaningful difference, $p<0.05$ meant there was a meaningful difference.

Results

Students' Achievement

One-way ANOVA was used to compare the GAT mean scores for the responses. As seen in Table I, at the beginning the pre-test means of EG1, EG2, and CG were 6.416, 6.541 and 6.250, respectively (see Table I). These results showed that the sample's pre-treatment knowledge levels were very close to each other and there was not a statistical difference between the groups ($F(2, 69) = 0.088$, $p > 0.05$). But, at the end of the treatment, the post-test scores of EG1, EG2, and CG were 15.375, 12.375 and 8.166, respectively. A statistical significant difference was found between the groups ($F(2, 69) = 47.764$, $p < 0.001$). Post-hoc analyses, using L.S.D., show that the EG1 differed significantly from EG2 and CG. Furthermore, EG2 had significantly the second higher mean scores. The mean scores from the experimental groups were all significantly higher than the mean score for CG. This means that all instructional software programs had significantly higher effect than CG.

Table I. **One-way ANOVAs with post hoc comparisons for the four groups' CAT scores**

	N	M	S.D.	df	Mean Square	F	Sig.	Post hoc
Pre-test								
EG1	24	6.416	2.780					
EG2	24	6.541	2.146	2	0.514			
CG	24	6.250	2.269	69	5.830			
Total	72	6.402	2.383	71		0.088	0.916	

Post-test								
EG1	24	15.375	2.081					
EG2	24	12.375	2.825	2	314.681			
CG	24	8.166	2.729	69	6.588			
Total	72	11.972	3.907	71		47.764	0.000*	EG1>EG2>CG

Students' Attitudes

Table II presents the results of a one-way ANOVA analysis for the BAS. The means related to biology attitude of the EG1, EG2, and CG before the treatment were 52.791, 53.416, and 52.375, respectively and there was not a statistical significant difference from one another (F (2, 69)=0.095, p > 0.05). After the treatment, post-test scores of the EG1, EG2, and CG were 59.250, 63.875, and 58.625, respectively. There were significant differences in mean scores for biology attitudes, as measured on the BAS, for students from the three groups (F (2, 69) = 3,488, p < 0.05). The Post-hoc L.S.D. revealed that the students from the EG2 reported higher mean score for BAS differing significantly than CG. However, the expected attitude change did not occurred in the EG1. These results illustrate that the only edutainment software program influenced students' attitudes towards biology lessons in a positive way.

Table II. *One-way ANOVAs with post hoc comparisons for the four groups' BAS scores*

	N	M	S.D.	df	Mean Square	F	Sig.	Post hoc
Pre-test								
EG1	24	52.791	8.235					
EG2	24	53.416	9.287	2	6.597			
CG	24	52.375	7.347	69	69.354			
Total	72	52.861	8.221	71		0.095	0.909	
Post-test								
EG1	24	59.250	8.659					
EG2	24	63.875	6.848	2	197.375			
CG	24	58.625	6.920	69	56.591			
Total	72	60.583	7.781	71		3.488	0.036**	EG2>EG1,CG

Misconceptions

Before the implementation, we looked at percentages for each question in the pre-test. There was not much difference between the groups in terms of their prior knowledge level about the terms gene, DNA, nucleus, chromosome, allele gene, genetic information, and genetic code. For example, the misconception "Only, genes are determines our characteristics" determined as percent in experimental groups and control group are 25%, 20.8%, and 20.8%, respectively. After the implementation, some of the related concepts are examined in detail.

Misconceptions about genes

Students were asked to give their responses to the questions "Where, in your body, are genes found?". The misconceptions were intensified into two categories as "Genes are founds vague, everywhere." and "Genes are only found in specific organs or tissues (e.g. reproductive system)". Before the treatment the rate of misconceptions was 8.3% and 25% in EG1, 16.6 and 20.8% EG2, 12.5% and 29.1% in CG, respectively. After the treatment, the students' responses indicated that the misconceptions, decreased to 8.3% and 12.5% in the EG1, absolutely eliminated in both experimental groups and control group.

Students were asked to give their responses to the question "Why are genes important?". Before the treatment the rate of the most common misconception (genes are determines our characteristics) was 16.6% in the EG1, 20.8% in the EG2 and in the CG. After the treatment, misconception was 8.3% in EG1 and EG2, 8.3% in the CG. Students were asked to give their responses to the question "What are genes made up of?" and they also had a misconception that "genes are made up of other biological material proteins/amino acids". Before the treatment the rate of misconceptions was about 29.1% in the EG1, 41.6% in the EG2 and 33.3% in the CG. After treatment, the rate of misconceptions decreased to 25% in the EG1, 20.8%in the EG2, and 20.8% in the CG.

Misconceptions related to DNA

Students' understanding about DNA was probed using the questions "Where, in your body, is DNA found? and "Why is DNA important?". The most recognized misconceptions were grouped into two categories as "Chromosomes are made up of DNA" and "DNA is only found in specific parts of the body, most commonly the blood" in Table 3. The pre-test results showed that students had misconception at the

rate of 79.1% and 41.6% in the EG1, 87.5% and 33.3% in the EG2, 66.6% and 37.5% in the CG. After treatment, the rate of misconceptions decreased to 37.5% and 4.1% in the EG1, 12.5% and 12.5% in the EG2, 16.6% and 0% in the CG.

Misconceptions about chromosomes

Students were asked to give their responses to the questions "Where are chromosomes found?", What are chromosomes made up of?" and "Why are chromosomes important?". The results in Table 3 showed that students had some misconceptions that "chromosomes are made up of other chromosomes (e.g. X and Y chromosomes)", "same species have the same chromosome number" and "chromosomes are located in the nucleus". Before the treatment the rate of "chromosomes are made up of other chromosomes" misconception was 4.1% in the EG1, 4.1% in the EG2, and 16.6% CG. After the treatment, this misconception in all groups was absolutely eliminated. The rate of "same species have the same chromosome number" and "chromosomes are located in the nucleus" misconceptions decreased with respect to the before the treatment.

Misconceptions about nucleus

Students were asked to give their responses to the questions "Where is the nucleus found?", "What does the nucleus contain?" and "What is the function of the nucleus?". The misconceptions were grouped into three categories as "genetic materials are not found in nucleus" and "nucleus does not take a role at the control of cell function" and "nucleus is found in all cells". Before the treatment the rate of "nucleus is found in all cells" misconception was 79.1% in the EG1, 58.31% in the EG2, and 95.8% in the CG. After the treatment this misconception decreased to20.8% in EG1, 12.5% in EG2, and 8.3% in the CG.

Misconceptions related to allele gene

Students were asked to give their responses to the questions "How would you describe an allele?". Before the treatment the rate of "allele gene is a concept which can be used as an alternative of gene and chromosome" misconceptions was 29.1% in EG1, 25% EG2, and 37.5% in CG, respectively. After treatment, the rate of misconceptions decreased to 8.3% in the EG1, 4.1% in the EG2, and 12.5% in the CG.

Misconceptions concerning genetic information

Students' awareness about the genetic information was probed using the question "What do you think is meant by genetic information?". The misconceptions about the

genetic information were grouped into two major categories as "Genetic information is the same in all livings" and "all cells from one individual do not contain the same genetic information.". The pre-test results showed that students had misconception at the rate of 20.8% and 29.1% in the EG1, 29.1% and 37.5% in the EG2, 8.3% and 16.6% in the CG. After treatment, the rate of misconception, "genetic information is the same in all livings", decreased to 16.6% in the EG1, 12.5% in the EG2, and 0% in the CG. After the treatment, the students' responses indicated that the misconception, "all cells from one individual do not contain the same genetic information", absolutely eliminated in all three groups.

Misconceptions concerning genetic code

Students' awareness about the genetic information was probed using the question "what you think the genetic code means?". The misconceptions were grouped into two categories as "genetic code is a genetic structure which differentiates the individuals from each other" and "genetic code is a code which makes the human". The pre-test results showed that students had misconception at the rate of 25% and 12.5% in the EG1, 20.8% and 20.8% in the EG2, 20.8% and 29.1% in the CG. After the treatment, the students' responses indicated that the misconception, "genetic code is a genetic structure which differentiates the individuals from each other", absolutely eliminated in all groups. The rate of misconception, "genetic code is a code which makes the human", also eliminated in the EG1, 8.3% in the EG2, and 12.5% in the CG.

Table III: *Results of pre and post-test concerning misconceptions*

Categories and misconceptions	Pre-test %			Post-test %		
	EG1	EG2	CG	EG1	EG2	CG
1. Gene						
Genes are determines our characteristics.	16.6	20.8	20.8	8.3	4.16	8.3
Genes are founds vague, everywhere.	8.3	16.6	12.5	8.3	0	0
Genes are only found in specific organs or tissues (e.g. reproductive system).	25	20.8	29.1	12.5	0	0
Genes are made up of other biological material proteins/amino acids.	29.1	41.6	33.3	25	20.8	20.8
2. DNA						

Chromosomes are made up of DNA.	79.1	87.5	66.6	37.5	12.5	16.6
DNA is only found in specific parts of the body, most commonly the blood.	41.6	33.3	37.5	4.16	12.5	0
3. Chromosomes						
Chromosomes are made up of other chromosomes (e.g. X and Y chromosomes).	4.1	4.1	16.6	0	0	0
Same species have the same chromosome number	41.6	37.5	54.16	12.5	25	8.3
Chromosomes are located in the nucleus.	83.3	45.8	45.8	58.3	37.5	37.5
4. Nucleus						
Genetic materials are not found in nucleus.	16.6	4.1	4.1	8.3	0	0
Nucleus does not take a role at the control of cell function.	4.16	16.6	8.3	0	0	0
Nucleus is found in all cells.	79.1	58.3	95.8	20.8	12.5	8.3
5. Allele gene						
Allele gene is a concept which can be used as an alternative of gene and chromosome.	29.1	25	37.5	8.3	4.1	12.5
6. Genetic information						
Genetic information is the same in all livings.	20.8	29.1	8.3	16.6	12.5	0
All cells from one individual do not contain the same genetic information.	29.1	37.5	16.6	0	0	0
7. Genetic code						
Genetic code is a genetic structure which differentiates the individuals from each other.	25	20.8	20.8	0	0	0
Genetic code is a code which makes the human.	12.5	20.8	29.1	0	8.3	12.5

Analyses of misconceptions

In table 4, analyses of students mean scores for the responses on the GCT are given. At the beginning the pre-test means of EG1, EG2, and CG was 2.208, 2.041, and 2.500, respectively. Before the treatment, results indicated that misconceptions on understanding of the genetic concepts (gene, DNA, nucleus, chromosome, allele gene, genetic information, and genetic code) did not differ significantly across the groups (F

(2, 69) =0.254, p>0.05). After the treatment, post-test mean scores for the responses on the GCT of the EG1, EG2, and CG were 7.125, 4.500, and 4.208, respectively (see Table 4). There were significant differences in mean scores, as measured on the GCT, for students from the three groups (F (2, 69) =3.688, p<0.05). The Post-hoc L.S.D. revealed that the students from the EG1 reported higher mean score for GCT differing significantly than other groups. EG2 and CG did not differ significantly from one another. In other words, the expected conceptual change did not occurred in the EG2. Eventually, these results illustrate that the only tutorial software program influenced students' misconceptions in a positive way.

Table IV: *One-way ANOVAs with post hoc comparisons for the four groups' GCT scores*

	N	M	S.D.	df	Mean Square	F	Sig.	Post hoc
Pre-test								
EG1	24	2.208	1.693					
EG2	24	2.041	2.349	2	1.292	0.254	0.776	
CG	24	2.500	2.620	69	5.086			
Total	72	2.305	2.521	71				
Post-test								
EG1	24	7.125	2.559					
EG2	24	4.500	4.890	2	61.931	3.688		
CG	24	4.208	4.462	69	16.791			
Total	72	5.430	4.271	71			0.030**	EG1>EG2,CG

** p<0.05

Discussions and Conclusions

Computer-assisted instruction is a widely studied and supported method of teaching. Numerous meta-analyses and review articles have been published showing positive effect sizes supporting CAI over the other teaching methods on student's academic achievement (Bayraktar, 2001; Chambers, 2002; Christmann & Badgett, 2003; Fletcher-Flinn & Gravatt, 1995; Kulik, 1994; Lowe, 2001; Soe, Koki, & Chang, 2000; Tsai & Chou, 2002). The findings of this study concerning the effects on students'

achievement are consistent with the ideas of the previous reports. It was revealed in the study that the both of the experimental groups at genetic concepts achievement were more successful than the CG after the treatment.

The significant academic achievement of the students in the experimental groups could be explained by the fact that the instructional software programs created a learning environment in which students can learn at their own pace. Interactive teaching makes students more aware of their own knowledge. Software programs appeared to made students more active, compared with being passive recipients of knowledge as in CG.

In addition, in regard to students' academic achievement there were some differences between the experimental groups. The data obtained from GAT illustrated that tutorial software was more effective than edutainment software on students' learning's. In edutainment software, the game format was more on the foreground than tutor format. Students spent most of their time exploring strange locales, searching for clues and collecting needed items rather than benefiting from the science tutor. The game format offers possibilities that students often find appealing, but it must be emphasized that their purpose is first and foremost to develop, reinforce, and refine some aspect of learning. Unlike a simple noninstructional computer game, instructional games must retain instructional value as their primary goal. Whereas, several skills are typically used to play an instructional game, the focal point of the game should be on the application of well-defined learning skills.

Many studies have been implemented about the influences of computer based instructions on students attitudes do not agree whether it makes positive changes in attitudes towards science and science lessons (Mitra, 1998). For example, Selwyn (1999) reported that computer assisted material develops a positive attitude towards science education. In contrast to this, Shaw and Marlow (1999) suggested that computer assisted material do not show a positive effect on students' attitudes. In this study, only edutainment software programs were more effective than CG on student's attitudes.

Tutorial and instructional game designs are merged edutainment software program provided "more student-centered learning", teaching students how to learn by themselves. Students spent time exploring strange locales, searching for clues and collecting needed items as well as benefiting from the science tutor. However, there

was no different effect between the tutorial software program used experimental group and the control group on students' attitudes. Although there were some learning subjects to develop students' interests in tutorial software program, it also had some drawbacks. For example, following the pathways was time-consuming as the screen changes take too long. Images, animations, and diagrams were generally unclear and they had low resolution quality than students might expect to find in software program. Also, sounds used in this software program for example to reinforce correct answers, to prompt the student to illegal responses, to entertain the student were not chosen conveniently with the age of the students.

Misconceptions are very important during the learning processes of individuals. It is well known that it is not easy to eliminate the misconceptions by just employing traditional instructional methods. One of the alternative ways of overcoming this problem may be using computer assistant materials in science classrooms (Çepni et al, 2006). In the present study, only tutorial software program provided better learning environments for students to understand genetic concepts with respect to CG. Tutorial software program at building genetic concepts were more helpful than the CG after the treatment. However, this study revealed that there were still some misconceptions in the tutorial software program used experimental group even after the treatments. These misconceptions were generally related to the widespread lack of understanding of the physical link between chromosomes and genetic material, and the relationship between the behavior of chromosome in cell division and the continuity of genetic information both within and between organisms and thus to visualize and conceptualize them is difficult for students. This shows that misconceptions may be reduced and/or dismissed if teaching–learning activities are given at comprehension and application levels (Karamustafaoğlu et al., 2003).

It is critical that lessons are planned in such a way so as to concentrate using the computer assisted materials on the topics in a lesson that will help to computer assisted learning. Having an entire teaching module on a CD-ROM with multimedia assets are more effective to improve student's academic learning. Keeping the balance between the educational content and computer entertainment is critical to realize desired educational goals. Otherwise, changing students' attitudes towards science lessons without improving academic achievement will be distant from the purposes of CAI.

The findings of the study provide further support for the use of educational software programs in both research and teaching. The results revealed the need for the further researches to develop different teaching approaches for the situations that the aim of the teaching is completely eliminate any misconceptions. Findings might be useful for informing classroom practices in the teaching of science concepts and the development of suitable materials promoting students' understanding in science. Furthermore, teachers' awareness of students' misconceptions could itself contribute to the improvement of their teaching.

Although many educators devote tremendous efforts with great expectation that computer assisted material will dramatically increase students' achievement, the results of this study provide to classroom teachers a research-based evidence for positive outcomes by using different computer assisted materials in instruction. The present study also revealed the effects of some software's learning benefits from CAI experiences for students. It can be concluded that computer assisted materials could improve student achievement, and change misconceptions if it can achieve to keep the balance between the educational content and the entertainment, lastly improve students' attitudes toward biology lessons if it is designed with the consideration of students learning needs.

It is hoped that this investigation will serve as a motivating force for further interest and research in the area of effectiveness of educational software programs on students' understanding of science concepts, attitudes, and achievements.

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Appendix

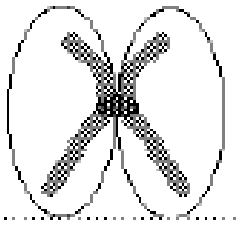
A. **Sample Questions from Genetic Concepts Achievement Test**

9. In vascular plants, DNA is contained in which of the following?

I. Nucleus
II. Chloroplast
III. Mitochondrion

A. I only
B. II only
C. I and II only
D. II and III only
E. I, II, and III

12. The two structures circled in the diagram below represent:
(The illustration includes one X-shaped object. One circle encloses the left hand side of the X and another circle encloses the right hand side of the X.)



A. pair of homologous chromosomes
B. two identical DNA molecules
C. two alleles
D. two gene location
E. a pair of gametes

18. A specific place on a particular chromosome where you would find a segment of DNA that codes for the production of a protein associated with the expression of a characteristic, for instance cystic fibrosis, would be called a/an:

A. Allele.
B. Centromere.
C. Nucleotide base.
D. Gene locus.
E. Recessive trait.

B. Genetic Concepts Concept Test

In these questions we are interested in what you know about the following biological terms: genes, DNA, nucleus, chromosomes, alleles, genetic information.
For each term, please answer the questions

Genes
a) Where, in your body, are genes found?
b) What are genes made up of?
c) Why are genes important?
DNA
a) Where, in your body, is DNA found?
b) Why is DNA important?
Nucleus

a) Where is the nucleus found?
b) What does the nucleus contain?
c) What is the function of the nucleus?

Chromosomes

a) Where are chromosomes found?
b) What are chromosomes made up of?
c) Why are chromosomes important?

Alleles

How would you describe an allele?

Genetic information

What do you think is meant by 'genetic information'?

The genetic code

Do you have any idea what is meant by 'the genetic code'

C. **Items of the Biology Attitude Scale**

1. Biology is not very interesting to me.*
2. I like reading about biology.
3. Biology is important in our daily lives.
4. Doing biology problems is not fun.*
5. I would like to learn more about biology.
6. I really do not enjoy going to biology lessons.*
7. I look forward to biology lessons.
8. We should have more biology lessons each week.
9. Learning about biology is boring to me.*
10. I would like being a biologist after I leave school.
11. Looking through a microscope is not interesting to me.*
12. Biology is important for understanding the natural life.
13. Biology is one of the most interesting school subjects.
14. I like to talk to others about biology.
15. Studying about biology is a waste of time.*

*The scale scores were reversed for asterisked items.