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The Effect of Educational Simulation on Learning and Academic Self-Efficacy of Students in Experiential Sciences Class

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ABSTRACT

The present research was conducted by the aim of investigating the effect of educational simulation on learning and academic self-efficacy in experiential sciences class in fifth-grade male students in the 4th district of Karaj, Iran. The statistical population included all the fifth-grade male students in elementary schools of the 4th district of Karaj in the academic year of 2019-2020. The study sample was selected by convenience sampling method and divided into two groups of 16 (experimental and control). The research method was semi-experimental with a pretest-posttest with control group design. The data collection tools included a researcher-made learning test and an academic self-efficacy test. To examine their validity, the comments and evaluations of teachers and professors were used. The reliability of the research instrument, that is the experiential sciences learning test, was determined by the Coder Richardson 21 which equaled 0.82, and 0.80, respectively and the Cronbach's alpha for the academic self-efficacy test was 0.85. Univariate analysis of covariance was used to analyze learning test data and multivariate analysis of covariance was used to assess academic self-efficacy. The results showed that educational simulation had a positive effect on both variables of learning with %95 confidence level (F: 69.74, P: 0.000), and academic self-efficacy (F: 14.848, P: 0.000) in students of experiential sciences classes it can be used as a learning tool. Simulation education makes it easy for students to understand the method and nature of science in order to improve problem-solving, search and generalization, knowledge acquisition and promotion of positive attitudes.

1. Introduction

Educational simulation and educational computer games which are among the manifestations of technological advancement in the present era, would play an important part in education in the future (Demirbilek, Ylmaz and Tamer, 2010). Using simulation in education has various benefits. Increasing creativity, attention, focus, imagination power, motivation and performance can be mentioned as the advantages of such advancement (Tamjid Tash, 2011; Kim, Park & Baek, 2009; Ketamo & Suominen, 2010).

In the past studies, computer simulation has been shown as an effective tool for students' education on difficult concepts especially in experiential sciences (Lindgren, Tscholl, Wang & Johnson, 2016). Today's learners belong to a different generation. A generation surrounded by computers, video cameras, mobile phones, and other digital tools and utensils. The new generation can be referred to as "the network generation", or "the digital generation" or "digital natives". This generation is the native speaker of the computer digital language, computer games and internet. Compared to this group, those not born in the digital era who are not fully adapted to new technologies can be called "digital immigrants". Although immigrants get adjusted with the movement environment, they have a little bit of accent just like all the other immigrants. Now, the biggest problem that education is faced with is that digital immigrant educators who speak with an obsolete language (related to the pre-digital era), try to educate a population who speaks with a totally new language (Prensky, 2005). The growth of digital technology two parts of which are simulations and computer games, has changed the thinking pattern and information processing. In a way, these technologies are the cultural tools mediating the mental action which have become the mediator between the individual and his/her surrounding area. The individual reflects himself through them and in this interaction, his ways of thinking, control and behavior organization demand a change with specific cognitive capacity (Mohseni, 2014); This has led to the fact that the thinking pattern and preferences of today's young individuals are quite different compared to their parent and prior generation. The cognitive changes created by new digital technologies have led to new needs and preferences in the new generation, particularly in learning. Simulation is one of the best methods which satisfy the needs of the new generation in learning (Prensky, 2005). Apparently, according to the developments mentioned in the prior section, turning to active learning method and academic self-efficacy is one of our primary tasks in the education of the present era; A type of education which is able to create alive and dynamic scientific processes, improve the spirit of enquiry, curiosity and creativity with a pluralistic approach and flexible understanding, and therefore, is able to nurture learners who can understand the way of making proper use of the new communication technology, maintain their authentic culture, identity and national dignity, and also get prepared to face the future issues. One of the most efficient new methods in education is to teach self-efficacy in learning to students (Alaei, 2005).

Methods:

The present research was conducted by the aim of investigating the effect of educational simulation and academic self-efficacy among fifth grade students in experiential sciences class in the 4th district of Karaj city, Iran. The present research was conducted by semi-experimental method with a pretest-posttest with control group design. The statistical population included all the male fifth grade student in the 4th district of Karaj city in the academic year of 2019-2020. The multi-stage cluster sampling method was used to collect the data; First, one school was selected among all the elementary schools of the 4th district of Karaj city. Afterwards, two classes were selected among all the fifth-grade classes.

Initially, all the subjects which equaled 32 individuals, completed a learning and self-efficacy test, and then, the subjects were divided into two experiment and control groups (16 subjects per group). To assess the subjects, a researcher-made learning test and the Morgan-Jinks Student Efficacy Scale were used; for appraising the validity of the test, the comments made by the supervisor and advisor professors and the teachers were used. The procedure was conducted this way: the experiment group subjects were trained by the simulation software and the control group subjects were trained through normal methods of the school. Afterwards, both groups took a posttest learning test, and both groups completed the Morgan-Jinks Student Efficacy Scale in order to obtain the data on academic self-efficacy of the students. The formal method was used to confirm the validity of the tests and the tests were examined and confirmed by experts (related professors and teachers) in a number of steps. To estimate the reliability of the learning test and the Morgan-Jinks Student Efficacy Scale, the Koder- Richardson method and Cronbach's alpha method were used, respectively. The reliability of the learning test and academic self-efficacy test equaled 0.80 and 0.85, respectively.

Findings:

In this section, the results obtained from the sample are generalized into the statistical population. The covariance analysis method has been used in the current research. Therefore, in order to use the covariance analysis method, first the basic assumptions of this statistical method, that is, the normality of the data, similarity of the regression slope, and the homogeneity of the groups' variances have been investigated.

Investigation of the assumptions of Univariate analysis of covariance (first assumption)

Data normality test

Table 1: Results of Kolmogorov-Smirnov test to evaluate the normality of scores distribution

Variable	Number	Kolmogorov-Smirnov Z	Significance level
Learning pretest	32	0.807	0.533
Learning posttest	32	0.616	0.842

In table 1, the results of the Kolmogorov-Smirnov test for investigating the normality of the scores distribution of the learning test are presented. Based on the results presented in table 1, the significance level calculated for all the variables is greater than 0.05; Therefore, the assumption of normality for pretest and posttest scores' distribution is accepted.

A) The assumption of homogeneity of variances

Table 2: Levin's test for investigating the homogeneity of error of variances

F	Degree of freedom 1	Degree of freedom 2	Significance level
0.193	1	30	0.664

At first, the assumption of error of variance's homogeneity between the groups is investigated by Levin's test. According to table 2, it can be observed that with $p>0.05$ and $F=0.193$, the assumption of error of variance's homogeneity between groups is confirmed.

B) Similarity of the regression line slopes

Table 3: Analysis of variance test for investigating regression coefficients in both groups

Variable	Sum of squares	Degree of freedom	F	Significance level
Group	3.68	1	1.87	0.182
Pretest	0.52	1	0.26	0.609
Group*pretest	0.02	1	0.01	0.906
Error	55.22	28		
Total	8320.00	32		

According to table 3, the variance analysis test for investigating regression coefficients is confirmed with F = 0.01, degree of freedom = 1, and significance level = 0.906.

First assumption: Using educational simulation has a positive impact on the learning of students in the experiential sciences classes.

To investigate this assumption, two groups with 16 subjects each were randomly selected from the school. Both groups took a pretest on learning in order that the students' level would be assessed and the similarity of their levels would be confirmed. Afterwards, 16 students were trained by educational simulation and the other 16 students were trained by regular method. After completing the training, the learning posttest was given to both groups. The data analysis is presented in tables 4-6.

Table 4: The results of the analysis of covariance between the learning posttests of both groups (pretest effect is omitted)

Effect size	The significance level	F	Degrees of freedom	sum of squares	Statistical index
0/69	0/612	0/26	1	0/50	**Source**
0/70	0/000	69/74	1	132/87	**pre-exam**
			29	55/24	**group**
			32	8320/00	**error**

In table 4, the results of the analysis of covariance for the posttest scores of learning after adjusting the pretest. Based on the results obtained from table 4 (F = 69.7445 & df = 1.29), it is observed that when the pretest effect is removed from the results of the groups' follow-up, the difference between the groups is significant with 95% confidence on 0.000 confidence level; therefore, it can be said with 95% confidence that educational simulation has a positive effect on learning among male students in experiential sciences class.

Investigating the assumptions of the multivariate analysis of covariance (related to the second assumption):

The data normality test

Table 5: Results of the Kolmogorov-Smirnov test for investigating the normality of self-efficacy scores' distribution

0/929	**0/543**	**32**	**Academic self-efficacy pre-test**
0/437	0/869	32	**Academic self-efficacy post-test**
0/452	0/859	32	**Talent pre-test**
0/435	0/870	32	**Aptitude test**
0/541	0/802	32	**pre-test effort**
0/753	0/675	32	**Effort post-test**
0/924	0/548	32	**Texture pre-test**
0/693	0/711	32	**Texture post-test**

In table 5, results of the Kolmogorov-Smirnov test for investigating the normality of pretest-posttest scores' distribution for academic self-efficacy and its sub-components. Based on the results shown in the table, the significance level of the statistic calculated for all the variables is higher than 0.05; therefore, the assumption of normality of scores' distribution of pretest and posttest stages is accepted.

The assumption of variances' homogeneity

Table 6: Results of the covariance matrices similarity test (box)

Significance level	Degree of freedom 2	Degree of freedom 1	F	Box's
0/554	6520/755	6	0/82	**5/522**

As seen in table 6, the significance level of the Box test equals 0.554. since this value is greater than the significance level needed for rejecting the null hypothesis (0.01), our null hypothesis respecting the similarity of the matrices of covariances is confirmed. Thereupon, the assumption of covariance matrices' similarity is established as one of the assumptions of the multivariate analysis of covariance.

Table 7: Results of the Levin's test for investigating variances' homogeneity

Significance level	Degree of freedom 2	Degree of freedom 1	F	Variable
0/220	30	1	1/569	**talent**
0/305	30	1	1/088	**effort**
0/592	30	1	0/294	**Texture**

As observed in table 7, results of the Levin's test are not significant in none of the variables. Ergo, our null hypothesis regarding the homogeneity of variables' variances is accepted. So, it is concluded that another assumption of the multivariate analysis of covariance test, variances' homogeneity, is established.

Table 8: Results of the multivariate analysis of covariance for comparing the sub-components of academic self-efficacy in both groups

Effect	exams	Value	F	Hypothesis df	Error df	Sig
Group	Pillai's Trace	0/623	14/848	3	27	0/00
	Wilks' Lambda	0/377	14/848	3	27	0/00

Hotelling's Trace	1/650	14/848	3	27	0/00
Roy's Largest Root	650	14/848	3	27	0/00

As seen in table 8, the significance levels of all the four multivariate statistics, that is, Pillai's Trace, Wilks' Lambda, Hotelling's Trace, and Roy's largest root test are less than 0.01 ($p<0.01$). Hence, the statistical null hypothesis is rejected and it is determined that there is significant difference between the scores of experiment and control groups in all the components of academic self-efficacy in posttest. To investigate the difference of the experiment and control groups in each of the components, the within-subject effects test was used, the results of which are presented in the following table.

Table 9: The within-subject effects test for comparing the components of academic self-efficacy in experiment and control groups in posttest

Variables	Source	sum of squares	Degree of freedom	mean square	F	Significance level
talent	between groups	6/192	1	6/192	22/898	0/000
	Intergroup	8/112	30	0/270		
effort	between groups	4/390	1	4/390	18/511	0/000
	Intergroup	7/115	30	0/237		
context	between groups	5/651	1	5/651	13/014	0/001
	Intergroup	13/161	30	0/434		

In table 9, the results of the within-subject effects test for comparing the components talent, effort and context as the sub-components of academic self-efficacy in the experiment and control groups in the posttest are presented. According to the presented results in table 9, the obtained F value for all the variables is significant on 0.05 significant level; Therefore, the null hypothesis is rejected and the research hypothesis is confirmed; And based on the greater mean scores of the experiment group subjects in the posttest stage, it is concluded that using educational simulation has a positive impact on each of the components of academic self-efficacy amongst male students in the experiential sciences course.

Discussion and conclusion:

According to the results shown in table 4 which presents the results of analysis of covariance for comparing posttest means of both groups with controlling the pretest effect, it can be said with 95% confidence that the experiment hypothesis regarding the effect of educational simulation on learning of students in experiential sciences class, is confirmed. In other words, sufficient evidence show that learning is considerably higher among students who have been trained by educational simulation compared to students trained by regular methods. The findings of the present research are consistent with the results obtained by Salimi, Rastegar Pour, and Mohammad Hassani (2017), Mahmoudi and Hosseini (2015), Lakdashti and colleagues (2011), Alt (2018), Vellachopoulus and Meckry (2017), Akhu-Zehie, Gharibeh, and Allostez (2013), Ruten, Von Julingen and Von Der Vein (2012), Hallzeinger, Kick Mayer, Vazteorer, and Hezinger (2009), Kim, Park, Lee, and Lee (2005).

In all these studies, the use of active teaching method particularly the use of educational simulation and educational software in the teaching process has been highly emphasized; And this method has been referred to as an effective method in education. According to the investigations conducted so far and the results obtained from these investigations, a number of reasons can be mentioned for such results which come as follows:

- Offering timely feedback in accordance with students' choices and responses
- The possibility of reusing the educational application, because of its repeatability
- Simultaneous and conscious use of a number of senses in the learning process because of different components of a software such as voice, movement, text, image, graphic and color
- Novelty, recency and unique attractiveness in in the presentation of educational contents in the educational simulation software increase the interest and attention of the learners, and this, per se, is a bridge for creating an enjoyable learning
- Activity, involvement and mutual interaction of learners with content in the education process which, eventually, lead to meaningful learning; And this is realizable through an educational simulation software which has interactive properties.

Using educational simulations in teaching leads to increased learning among students, and we also notice that when students see, touch, create and destroy the contents in a simulated environment, this will lead to a better performance, consistent learning and academic achievement for them (Zolghadr Nasab and colleagues, 2015). The use of educational simulations leads to the fact that learning the contents will not be just mnemonic and this leads to more comprehension and understanding of the contents. By using simulation, educational conversations and materials becomes more objective and tangible; Sometimes they even discover very minute and subtle details while observing and working with simulation which stick to their minds forever. So, the more they use their senses, the more their talents and creativity will be activated and the teacher will also get a better result from his/her work (Hosseini Nik, 2015). Hence, proper and right use of educational media such as educational simulation by the teacher can enhance the performance and learning amongst students.

The second hypothesis: educational simulation has a positive impact on academic self-efficacy of students in the experiential sciences class.

According to table 8 which presents the results of analysis of covariance for comparing the means of the academic self-efficacy test in both groups by controlling the pretest effect, it can be said with 95% confidence level that the experiment hypothesis regarding the positive impact of educational simulation on the academic self-efficacy of students trained by educational simulation in the experiential sciences class, is confirmed. In other words, sufficient evidence shows that academic self-efficacy of students who have been trained by educational simulation is considerably higher than students trained by regular methods of schools. The findings of the present research are consistent with the findings of Asadollahi and Karimi Pour (2016), Ghonvati and Beheshti Pour (2014), Heidarzadeh, AzizZadeh, Kazemi, and Jahani (2014), Dortaj and Delavar (2005), Vellachopoulus and Meckry (2017), and Kim, Heo, Jeon, and Jung (2015).

The reason why the result obtained in the present research regarding the second hypothesis is confirmed and it is consistent with many studies in this domain, is related to the characteristics of the educational simulation which provides real and objective experiences to the students and, therefore, leads to increased and more efficient activity amongst them. Moreover, educational simulation teaches a skill in a complete and effective way and provides and experience for students which is not providable in any other methods. When students use educational simulation, they are able to get back

a feedback instantly which provides a positive reinforcement for them, and these positive reinforcements, in turn, can lead to self-efficacy and self-belief among them (Velayati, 2012). Since experiential sciences is a completely abstract class in elementary school, using educational simulation and objectifying the materials for students can be highly effective on their self-efficacy and self-belief. The behaviors and feedbacks observed by the researcher and teachers from students during training by educational simulation showed the motivation and interest of students towards the educational subject, and the class teacher also noted that the activity level of students had increased compared to the past and all the students were conversing on the material and had an active role in education. Although the students were more engaged with and curious about the application interface in the first two sessions, from session 3 onwards, the students showed more activity in the discussions proposed in the class and they continuously asked the teacher to use this application for other classes as well. One notable point was that even after the educational class the students were engaging with the discussions and questions presented in the simulation and they were discussing and conversing about the materials. In a final and general remark and by relying on the past research, it can be concluded that, due to the use of different senses in the educational process, educational simulations are able to transform the learning setting and attract the students and learners to the learning process, inject new reinforcing stimulants into the education and learning procedure, help to consolidate sustain the learning material, and lead to improved education quality and academic self-efficacy.

Generally, research indicates that the method of presenting the learning material is significantly effective on the learning process and, consequently, on the performance of the learner (Halzinger, Rust, Vasertor, and Hessinger, 2009). Contemporary educational approaches expect the students to be active producers of knowledge. This approach leads to the need to develop educational tools and activities which provide active learning settings for the students. Scar Damalia and Printer (1991) and Faed (2007) state that, if designed appropriately, computerized learning settings can support explorative and constructivist learning and, as a result, create a more prominent role for the learners in the learning process (quoted from Cycaris, 2010). The Science education domain is deeply related to experiences, observations, experimental or practical facts. Along with the theoretical support which provides the essential knowledge for the learners, practical knowledge based on observations or experiments is also inevitable in scientific research (Gorghi u and colleagues, 2010).

Laboratory researches create a ground for gaining objective experiences. Objective and inquiry-based experiences not only are essential for increasing interest and gaining better attitude in Science education, but they are also important for showing the relationship of the subject matter (Kelly, Bradley, and Gratch, 2008).

Education by using simulation leads the students to easily understand the method and nature of Science in order to improve their problem-solving skills, inquiry and generalization, obtain knowledge and enhance positive attitudes (Byrack, 2007). In real settings where they can observe concepts and processes, students are able to learn knowledge easier. Simulated settings are employed extensively for teaching such subjects. When students are engaged in studies in a simulated setting, their interests and achievements in Science subjects will increase.

What is clear is that computer-based teaching and learning is becoming increasingly widespread. Computer-based learning is a method in which computers are used as the learning media that highly strengthens the students' motivation and the education process; This method creates opportunities for students and teachers by which learning and teaching would be realized way faster, and also makes it possible to foster active learning by using computer technology. It has been observed in recent studies that computer-based learning is far more effective than any other traditional method.

However, what is definitely important eventually is that this point must be notices that teachers have to consider using more and more optimum resources available according to the existing possibilities. Using educational simulations for Science learning is highly effective and the educational simulation should seek to provide this learning setting for the learners. Many educational institutions can spread and simulation applications based on a general understanding of technology and the educational potential of this tool. Making use of the simulation educational method can have a high learning rate compare to other educational methods. Furthermore, this method creates the opportunity to control the complexity of events. By integrating simulation into the educational processes, the chance to acquire skills and learn to solve the problems with minimum waste of time and resources will be created. Compared to other methods and techniques, this educational method is an effective and unique method for acquiring communication skills which can be a tool for changing attitudes of the learners.

Finally, the decision-making skills and self-efficacy of the learners can be promoted by the help of simulation. Based on the research conducted by the author by the aim investigating the effect of computer simulation on learning and academic self-efficacy which has led to positive results regarding the impact of simulation on learning and self-efficacy, and also the above-mentioned findings of other researchers in this ground; it appears that by conducting qualitative and quantitative research in the field of the impact of simulation, new and brighter horizons in the field of novel and computer-based methods of learning, education and teaching can be found. Today, the primary issue in education is not to access more information. In fact, one challenge of the learners is to give meaning to the volume of the content with which they are faced and to purposefully absorb all the information. Due to the information explosion and its accompanying advancements in communication, we need new approaches. Learning strategies are among the effective factors in learning which are acquirable. Using one strategy, not only makes it easy to learn the concepts and materials, but also makes them meaningful; and if applied in an inappropriate way, it can consolidate the learning in the memory for a long time. One novel educational strategy which plays an important role in this ground is using computer simulations. Since there is a need to design a suitable model for both learning and teaching in order to use simulation in learning, researchers are recommended to work in this area, expand the mechanisms used in simulation in future, and make use of it as an efficient tool in the field of education.

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