Students' and Teachers' Attitudes towards using Simulations in Inquiry based Learning in Chemistry Class (Short Paper)

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Abstract

Computer simulations are software programs designed to describe a scientific model or phenomenon with a high level of accuracy and reliability. Only a few studies have focused on examining its effects on students and teachers' motivation.

The main research questions are:

- Does a relationship exist (and to what extent) between simulation-based learning and students' motivation to learn chemistry?
- What are the teachers' attitudes regarding the use of simulation in science class?

The study comprised 50 students from two eighth-grade classes in northern Israel: 23 students studied the atomic structure and the hydrogen model using computer simulations for two weeks, and 27 students learned via teachers' explanations (traditionally). All of the students answered a motivation questionnaire towards the end of the intervention. In addition, 31 science teachers replied to an attitude questionnaire to express their opinions about using simulation in science class.

Findings from the students' motivation questionnaires indicated high levels of interest, desire and self-efficacy. However, no significant differences were found between the experimental and the control groups. Additionally, the teachers showed high motivation to use simulation in their science class. Contrary to expectations, most stated that they did not need any help or support in acquiring ICT skills.

Keywords: Simulation, Motivation.

Introduction

Special emphasis has been placed on adapting science and technology instruction to the spirit of the advanced age. Computers and technology-based environments could be among the promising approaches, yet many teachers mainly still use traditional teaching methods. Specifically, computer simulations may support innovative teaching, help facilitate teachers' professional development, and enable users to become active learners and researchers. Nevertheless, only a few studies have focused on examining the motivational aspects related to using this technology among students and teachers. The literature on this issue is relatively limited. Therefore, this study sought to highlight students and teachers' motivation in using simulation in science class.

Literature Review

Simulations for promoting inquiry-based learning

Inquiry-based learning is one of the best approaches that places students' questions, ideas and observations at the center of their learning experience (Scardamalia, 2002). It is a process of discovering new causal relationships, whereby the learner is required to formulate hypotheses and test them by conducting experiments and/or making observations. The student is required to use cognitive resources in order to infer, analyze and link previous knowledge with the new knowledge he is seeking to acquire.

In classes where it is difficult to create a real inquiry environment using simulations, a software program aimed at describing a phenomenon could facilitate accomplishing this task. Kali, Levy and Levin-Peled (2011) argue that the use of simulation can accelerate exploratory learning; the student can be active, and control the data affecting the system and the results of operating it. Students can also use the same simulation a number of times and examine the data repeatedly, allowing for optimal learning and better understanding of the subject. Rutten et al. (2012) assert that simulation could be beneficial especially when paying attention to the way that data are presented, the time during which the simulation is used, class settings and teachers' scaffolding.

Motivation to learn

Many studies emphasize the importance of motivation in students' learning. Some researchers even claim a connection between students' motivation, achievements and abilities to understand (Osborne, Simon & Collins, 2003). Hill (2007) mentions a range of key factors affecting students' motivation to learn, for example, contextualization learning in the students' world, bringing real-world subjects into the classroom, giving choice and autonomy to students to control their learning, and providing feedback. Schunk (1991) refers to self-efficacy as one of the most important components of motivation. Accordingly, a highly motivated person will have a high ability to perform successfully a particular task he is facing.

Research

Research questions

The current research aims at examining the use of simulation as a tool for advancing students' motivation to learning in chemistry class. The questions that guided this study were:

- Does a relationship exist (and to what extent) between simulation-based learning and students' motivation to learn chemistry?
- What are the teachers' attitudes regarding the use of simulations in science classes?

Research method

The study adopted the quantitative approach. The research was designed as a quasi-experimental study. In class 1, students learned science via simulation, whereas in class 2, students learned in the traditional way. This study was conducted during after-school hours as a preparation and review for students towards the final exam.

Before conducting the study, both groups had actually learned the material in a similar way in their regular class. In other words, each group had studied the content twice as described below:

Class 1: traditional method (first time) + simulation-based learning (second time)

Class 2: traditional method (first time) + traditional method (second time)

The students were divided randomly between the two classes. The two class educators asserted that the intervention and the control groups were very close and similar in terms of achievements (grades and averages) according to their midterm grades.

Data were collected by questionnaires, and statistical processing was performed to confirm or refute our basic hypotheses.

Research populations

The research population comprised fifty 8th-grade students from the Arab sector in northern Israel. Two similar classes in the school were chosen to participate in this research. The classes were merged, and divided again, as described earlier. The students learned about different subjects such as the atom structure (see Fig. 1) and the hydrogen model.

In addition, 31 middle school science teachers in northern Israel participated in a professional development forum and answered an attitude questionnaire regarding the simulation.

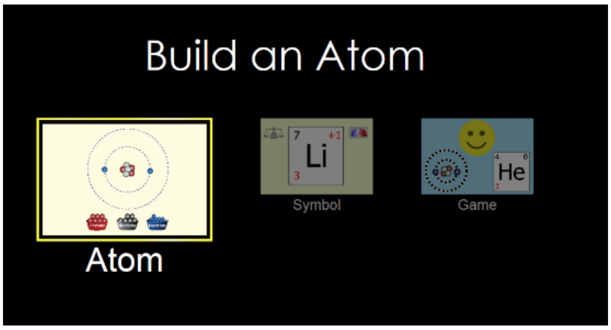

Figure 1. The atom structure.

Research procedure

In the first class, the teacher used simulation to explain his ideas and the students answered questions related to this simulation. Four different simulations were used to express different concepts in chemistry.

In the second class, the teacher explained the material theory, and the students answered 'regular' hand-written questions about the material.

Research tools

Students' motivation questionnaire: comprised 12 items on a scale of 1-4 that spread over three categories: Interest in learning with simulation; Desire to use simulation in learning; and Self-efficacy in simulation-based learning. The items were based on the research questionnaire of Awad and Barak (2014). Alpha Cronbach values ranging between 0.66-0.72 were received in the different categories.

Teachers' attitude questionnaire: comprised 30 items on a scale of 1-4 that spread over four categories: Interest in teaching science with simulation; Desire to use simulation in teaching; Self-efficacy in simulation-based teaching; and Use of simulation as an instructional model. Most of the items were taken from the studies of Omar (2011). Items were changed to fit the current study. Alpha Cronbach values ranging between 0.64-0.82 were received in the different categories.

Findings

Students' motivation to use simulation

Distribution of the students' answers

The students' answers indicated their high motivation to use simulation in science class. In most of the items, more than 80% of the students expressed "totally agree" or "agree" to reflect their approval in using simulation. For example, 94% of the students agreed (scales 3, 4) with the item: "Simulation encourages me to learn science seriously"; 88% agreed with the item "Simulation promotes me to learn science alone."

Deviation of students' responses from the middle of the scale

A t-test was conducted to compare the average of each category with the mid-scale value of 2.5. Findings in Table 1 show significant differences in the three categories

Table 1. t-test to compare the average score of students' responses to questionnaire categories with the mid-scale score (2.5).

Category	Average	t	df	P
Interest in learning with simulation	3.13	10.983	49	0.000
Desire to use simulation in learning	2.99	8.202	49	0.000
Self-efficacy in simulation-based learning	3.18	8.582	49	0.000

Students' differences in the control and experimental groups

To compare between the control and experimental groups, an independent t-test was executed. Table 2 presents the comparison results.

Table 2. t-test to compare students' averages in the control and experimental groups.

Category	Average – Control Group (n=27)	Average – Experimental Group (n=23)	t	df	P
Interest in learning with simulation	3.19	3.43	1.664	48	0.103
Desire to use simulation in learning	3	2.98	0.171	31.21	0.865
Self-efficacy in simulation-based learning	3.15	3.22	0.432	48	0.668

Relationship between students' motivation components

A Parson test was conducted to examine the relationship between interest, desire and self-efficacy. Findings in Table 3 show no significant differences. In other words, no relationship exists between any two of the motivation components.

Table 3. Parson Coefficient to examine the relationship between students' motivation components.

Category	Interest in Learning with Simulation	Desire to Use Simulation in Learning
Interest in learning with simulation	---	
Desire to use simulation in learning	- 0.032	---
Self-efficacy in simulation-based learning	- 0.008	0.116

Teachers' motivation to use simulation

Distribution of teachers' answers

About 70-80% of the teachers agreed (scales 3, 4) with the items phrased positively about interest, desire, self-efficacy and willingness to use simulation. For example, 77% of the participants agreed with the item: "I am looking for simulation to plan my lesson and students' learning." Additionally, the majority of teachers disagreed with the items phrased negatively. For example, 68% answered disagree and totally disagree (scales 1, 2) to the item: "I need the other's help in order to teach science topics by simulations." The teachers stated that they did not need special help in using simulation.

Deviation of teachers' responses from the middle of the scale

A t-test was conducted to compare the average of each category with the mid-scale value of 2.5. Findings in Table 4 show significant differences in all four categories.

Table 4. t-test to compare the average score of teachers' responses to questionnaire categories with the mid-scale score (2.5).

Category	Average	t	df	P
Interest in teaching science with simulation	3.177	5.421	30	0.000
Desire to use simulation in teaching	3.371	11.780	30	0.000
Self-efficacy in simulation-based teaching	3.096	7.075	30	0.000
Use of simulation as an instructional model	3.233	9.417	30	0.000

Relationship between the teachers' motivation components

A Pearson correlation was conducted to examine the relationship between interest, desire, self-efficacy, and the actual use of simulation as an instructional strategy.

Table 5. Parson Coefficient to examine the relationship between teachers' motivation components.

Category	Interest in Teaching Science with Simulation	Desire to use Simulation in Teaching	Self-efficacy in Simulation-Based Teaching
Interest in teaching science with simulation	---		
Desire to use simulation in teaching	0.736**	---	
Self-efficacy in simulation-based teaching	0.257	0.465**	----
Use of simulation as an instructional model	0.665**	0.698**	0.573**

Findings in Table 5 show significant differences, except between self-efficacy and interest, where a weak correlation exists.

Discussion

The results of this study go hand-in-hand with other research studies (Stoeger, Fleischmann, & Obergriesser, 2015), which state that using simulation could really contribute to students' motivation. Students who are engaged in using simulations in their class could be more interested in learning science. Although the current study did not indicate to significant changes between students who used simulations and those who learned traditionally, it still worth examining the effect of using simulation for a long time on the students learning. As known, in educational outcomes are not noticeable in dealing with short-term intervention. Education process needs time, continuity and gradation in order to be prominent.

Regarding the teachers, the findings show a significant high motivation to use simulation. About 70-80% of the teachers agreed with the contribution of simulation and wanted to use it in their classes. Tables 4 and 5 present this high motivation. Moreover, the majority of the teachers claim that they do not need specific support or help in using these techniques.

The teachers' results as reflected in this study are in line with the literature review. Many researchers (Dewan & Riggins, 2005; Kleme & Cohen, 2013) point to teachers' positive attitudes and high motivation to integrate simulation in science instruction. In their opinion, using simulation could improve teachers' work and serve as a tool to address many aspects of the traditional instructional model.

Conclusions

Students are enthusiastic and motivated about integrating simulations in their studies. However, it is still recommended to assimilate the use of simulation as part of the regular instructional method for an extensive and continuous period, hopefully that such an intervention could contribute to students' achievements as well.

Moreover, the teachers support the use of simulation and express belief in its potential to upgrade class instruction. Hence, it is important to ensure teachers' access to these resources in order to guarantee a rich learning experience. Although teachers might evaluate their ICT performance as being high (no need for guidance or support), it is still recommend closely examining how they use it and what is their professionality level.

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