The Effect of Employing Electronic Static Infographic Technology on Developing University Students' Comprehension of Instructional Design Concepts and ICT Literacy

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ABSTRACT

The current study examined the effectiveness of the use of electronic static infographic (information graphic) technology to support university students' learning, to develop their comprehension of instructional design concepts and to improve their Information and Communication Technology (ICT) literacy. The researcher used an experimental design in which 64 students in an instructional design course in the second semester of the 2019-2020 were randomly divided into an experimental group and a control group. The students in the experimental group received treatment on instructional design concepts and ICT literacy with the aid of electronic static infographic technology while the students in the control group received instruction about the same topic using regular method of instruction without the aid of electronic static infographic technology. Pretest and post-tests were administrated for the students in the two groups. Analysis of the pretest and post-test scores revealed that the implementation of electronic static infographic to support students' learning contributed considerably in developing comprehension of instructional design concepts. There was significant difference at the level (0.05) between the post-test scores of the control and experimental groups with the benefit going to the experimental group. Based on the findings, the current study recommends the use of electronic static infographic technology to support students' learning in teaching instructional design courses.

Key words: Static Infographic, Instructional Design Concepts, Saudi Arabia

STUDY BACKGROUND

The technological revolution has increased the importance of modern communication technologies in teaching. These technologies have provided high quality electronic educational content that fits students' various learning styles. Such high-quality educational content would consider differences between learners, increase the effectiveness of teaching, and improve students' learning. In addition, the new technological innovations helped the students and their instructors in presenting the information in different formats that make the understanding of such information easy and straightforward. One of these formats of information representation is electronic static infographic technology.

The abundance of data and information has led to the emergence of infographic designs that play an effective role in simplifying this information and making it easier to read. "Infographics can be defined as presenting information within a certain flow with the help of various visuals and texts in a visual form." (Yildirim, 2016, p. 98). However, reviewing the previous studies showed that there are various terms for infographic that include data visualization, information

visualization, statistical graphics, information design, and information architecture (Smiciklas, 2011).

There are different proposed categories of infographic designs. For instance, Locoro et al. (2017) reported that there are three types of infographic designs that include static, interactive and animated. In another category, Siricharoen and Siricharoen (2015) proposed a variety of infographic design types including visual article, flow chart, useful attraction, number, timeline, data visualization (statistical based), compare and contrast, photo, how-to (process oriented), research results, and "did-you-know?" In another classification of infographic designs, Yildirim, (2016) reported that infographic designs can be classified into three categories of interactive, semi-interactive and non-interactive, based on their multimedia components. Siricharoen and Siricharoen, (2015) proposed two main ways to create infographic design. The first is to use an online infographic website (e.g., www.visual.ly and www.easel.ly). The second is to use static and intimated image editing software such as, MS Excel, MS PowerPoint or Publisher, Photoshop, and Paint.Net, Gimp, Inscape, Photoshop Express, Pixlr, Sumopaint, Creately and other open-source software to build infographics. In addition, Siricharoen and Siricharoen (2015) reported that

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there are many Apple and Android applications to create the infographics. After creating the infographic designs, the infographic products will be hosted on website. Yildirim (2016, p. 109) proposed a set of criteria for designing excellent types of infographic, these criteria include:

- Consistency should be provided between information and visuals.
- Maintain consistency of information, taxonomic level and layout of visualizations.
- Avoid noninstructive visuals and decorative images to prevent cognitive overload,
- Use top-quality information and visualization of it. Use only error-free information.
- Avoid unnecessary, irrelevant information and visuals that do not logically conform to the structure of the material.
- Make sure the visual quality is excellent.
- Use colors appropriate to the context.
- Visuals should contribute to the integrity of the program and not cause discomfort.
- Design concept should enhance the purpose.
- Visual structure of the subject should be self-explanatory.
- Maintain consistency of typographic features.

The literature shows that there are several advantages of using infographic technology in education. For instance, Darwish and Dokhni (2015) reported that using infographic technology in education has the following advantages: the possibility of using infographic technology in all fields, infographic is a tool that shows the shape of unfamiliar things, infographic technology can be presented multiple styles, infographic technology is easy to produce, and infographic technology allows presenting the information in a visual form. Furthermore, Kaya-Hamza, and Beheshti-Fezile (2017) summarized a set of advantages for the use of infographic technology in education that include: repeating information and date in regular or online education, conveying processes and events, management of course content, abbreviating learned information, presentation associations between ideas, provide to arrange the information properly, presenting data with the storytelling in an efficient way, provide imaginative visual design, provide efficient use of the technology which will positively affect the progress process of the learner, proper to be used in child's education.

Several research studies indicate that use of different types of infographic technology would be effective in enhancing students' knowledge and skills in various disciplines. Some of the research studies were conducted in the Arab world. For instance, Al-Hadad (2018) examined the effectiveness of motion infographic videos in enhancing Kuwaiti sixth grade students' performance in social studies class. The researcher used experimental research design in which a group of 86 students were divided into an experimental group with 46 students and a control group with 40 students. The students in the experimental group received instruction with the aid of motion infographic video, while the students in the control group received instruction without the aid of motion infographic video. The results showed

that motion infographic video was effective in enhancing students' learning in terms of increasing their academic achievement, increasing the retention of the information in their memory, and shortened the time for learning. In another study that was conducted in Palestine, Abo-Orbean (2017) examined the effectiveness of two types of infographic technology (illustrative graphics – animated graphics) in enhancing tenth graders' problem solving in genetic unit in life sciences class. The researchers employed experimental design in which 116 students were divided into three groups taught in different ways. The first was taught using illustrative graphics, the second was taught using animated graphics, and the control group was taught in the traditional way. The results showed that the students in the second group outperformed those in the other two groups in the post-test exam. In Saudi Arabia, a study by Alotiabi (2016) examined the effectiveness of instructional infographics on first intermediate students in English language grammar. The researcher followed experimental research design in which 41 students were randomly divided into experimental and control groups. The results showed that the students who received instruction with the aid of instructional infographic outperformed the students who received traditional instruction in English grammar achievement test based on Bloom's cognitive levels (remembering, understanding, applying, analyzing, and synthesizing). In another study that was conducted in Saudi Arabia, Shawoush (2019) examined the effectiveness of infographic technology on students' academic achievement in a computer class. The researcher followed experimental research design in which 60 students were randomly and equally divided into two groups, experimental and control group. The results of the study show that the use of infographic technology to teach computer subject would result in enhancing students' academic achievement better that using traditional method of teaching.

At the university level in the Arab world, there are numbers of research studies that examined the effectiveness of using infographic technology in enhancing students' academic performance. One of these studies was conducted in Egypt, where Abd-Alrahman and Ibrahem (2018) examined effect of three types of infographic technologies on university students' academic achievement and their level of digital graphic production skills. The three types of infographic technologies were illustrative graphics, animated graphics, and interactive graphics. The researchers used experimental and analytical design and set of tools that include immediate achievement test, practical test, and assessment card. The results showed that the students' in the three groups performed higher in the post-tests compared to their scores in the pretests at the immediate achievement test and digital graphic production skills test. In another study on the Egyptian higher education level, Ahamd (2018) examined the difference of the effects of static versus intimated infographic patterns on university students' skills of digital citizenship. The researcher followed experimental design in which a group consisted of 50 students, were randomly divided into two equal experimental groups, the first experimental group was taught through the illustrative

infographic pattern and the second experimental group was taught through the intimated infographic pattern. The study involved building the following tools: 1) List of digital citizenship skills, 2) List of educational infographic design criteria. 3) Scale of digital citizenship skills for students of higher education. The results showed that the students' in the two groups performed higher in the post-tests compared to their scores in the pretests related to the scale of digital citizenship skills. In Saudi Arabia, a study by Afify (2018) investigated how the difference between static and animated infographic designing types impacted development of visual learning of designing skills. The researcher followed experimental design in which 36 students were divided into two experimental groups. One of the groups (n=17) was taught the educational content with the aid of static infographics and consisted of students. The other group (n=19) was taught the educational content with the aid of animated infographics and consisted of 19 students. The participants were students in the College of Education taking a course in design and production of instructional media. The results showed that the infographics had contributed in the development of some learning outcomes. In addition, the static infographic type was more effective than the animated type in enhancing students' skills designing and producing visual learning materials and distinguishing its elements and principles,

The previous studies showed that the scholars have shown interest in infographic technologies and their application in education at school and university levels. These studies demonstrated that the use of infographic technologies has taken place in different majors. In addition, the previous studies show that the use of static infographic technologies has several advantages for the students. However, the use static infographic technology, to facilitate the university students' comprehension of instructional design concepts, was not examined in the previous studies.

PURPOSE OF THE STUDY

The previous findings of similar research studies have showed that electronic infographic technology has positive effect on students' learning in different disciplines and the at the school and university levels. The researcher noticed that the students in instructional design course have weakness in comprehending the concepts of instructional design. Therefore, the current study examined the effectiveness of electronic static infographic technology in enhancing in developing university students' comprehension of instructional design concepts. The current study addresses the following two research questions:

1. Are there significant differences in university students' comprehension of instructional design concepts and ICT literacy in pretest and post-test for the students in the experimental and control groups?
2. Are there significant differences in university students' comprehension of instructional design concepts and ICT literacy between the experimental group and the control group in the post-test exam?

STUDY METHOD AND DESIGN

Following the semi-experimental research design, 64 students were randomly divided into experimental and control groups. The experimental group consisted of 33 students, while the number of the students in the control group was 31. The students in the experimental group received instruction about instructional design concepts and ICT literacy with the aid of electronic static infographic technology while the students in the control group received instruction about the same topic using the traditional method of instruction without the aid of electronic static infographic technology. Pretest and post-tests were administrated for the students in the two groups.

PARTICIPANTS

The participants were university students who were taking instructional technology course offered by the department of instructional technology at the college of education at Albaha University. The participants had different majors that include physical education, special education, and art education. The participants were all males between 19-22 years old, in their third academic year.

STUDY TOOLS

Two tools were used in the current study. The first tool was a test that was administrated as a pretest at the beginning of the experiment and again as a post-test at the end of the experiment. The test was developed by the researcher and consisted of a set of multiple-choice questions. The test was developed to measure students' comprehension of set of instructional design concepts. The internal consistency of the used test was verified through the use of Cronbach's alpha that was found to be 0.84. The validity of the test was verified through presenting it to a group of experts who provided set of notes about the test's questions. The experts' notes were considered and used to revise the test's questions. The maximum score of the test was 3.

The second tool was set of infographics that were designed and developed to make set of instructional design concepts and ICT literacy easily comprehensible. The infographics were designed and developed by the researcher. The validity of the infographics was verified through presenting it to a group of experts who provided set of notes about the test's infographics. The experts' notes were considered and used to review the infographics.

PROCEDURES

The first step in the current study was acquiring students' approval to participate in the study. Then, the participants were divided into two groups: experimental group and control group. Before beginning of the experiment, the students in the two groups completed the pretest. Then, both groups had the same instruction about instructional design concepts and ICT literacy for four weeks, each week had a lecture that lasted for 120 Minutes. However. The students in the

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experimental group received their instruction with a set of infographics that were designed and developed to facilitate their understanding of the studied instructional design concepts. After the experiment, the students in the two groups completed the post-test. The pretest and post-test were administrated in the classroom and they were in the paper-based format. Each test lasted approximately 30 minutes.

DATA ANALYSIS

The tool used for data analysis was Statistical Package for the Social Sciences (SPSS) version 22. The data analysis procedure was conducted to answer the two research questions in the current study. To answer the first research question that examined the significant differences in university students' comprehension of instructional design concepts and ICT literacy in the pretest and post-tests for the students in the experimental group, the t-test for dependent samples was used.

To answer the second research question that examined significant differences in university students' comprehension of instructional design concepts and ICT literacy between the experimental group and the control group in the post-test exam, two types of statistical tests were conducted. Two sample t-test was conducted to inspect the variation between the means of the pretest results of the students in the two groups. Then, two sample t-test was conducted to investigate the difference between the means of the post-test results of the students in both groups in order to find out the impacts of the infographic experiment that is to say using electronic static infographic as learning support tool on developing university students' comprehension of instructional design concepts and ICT literacy in the experimental group.

RESULTS

Results Related to Question Number One: "Are there Significant Differences in University Students' Comprehension Of Instructional Design Concepts and ICT Literacy in Pretest And Post-Test for the Students in the Experimental And Control Groups?"

The results related to the first research question: Were as follows. The null hypothesis was there was no significant difference in experimental group students' mean scores in pretest and post-test that measure their comprehension of instructional design concepts. The alternate hypothesis was there was a significant difference in experimental group students' mean scores in pretest and post-test that measured their comprehension of instructional design concepts.

T-test for dependent samples for the pretest and post-test scores was conducted to compare the mean scores of the students in the experimental group before and after using electronic static infographic as learning support tool. Table 1 shows the results of the t-test for dependent samples for the pretest and post-test scores of the students in the experimental group.

The mean of the pretest experimental group was 1.52 and the mean of the post-test experimental group was 2.82. The standard deviation of the scores of the pretest for the experimental group was 0.80 and the standard deviation of the scores of post-test for experimental group was 0.47. The t-value was -8.474 and the degree of freedom was 32. The significant value was 0.00, which was less than 0.05. So, reject the null hypothesis was rejected. Therefore, there was a significant difference in experimental group students' mean scores in pretest and post-test those measure their comprehension of instructional design concepts and ICT literacy.

The mean of the pretest control group was 1.42 and the mean of the post-test control group was 1.94. The standard deviation of the scores of the pretest for the control group was 0.82 and the standard deviation of the scores of post-test for control group was 0.63. The t-value was -7.5 and the degree of freedom was 63. The significant value was 0.00, which was less than 0.05. So, reject the null hypothesis was rejected. Therefore, there was a significant difference in control group students' mean scores in pretest and post-test that measures their comprehension of instructional design concepts and ICT literacy.

Results Related to Question Number Two: "Are there Significant Differences in University Students' Comprehension of Instructional Design Concepts and ICT Literacy Between the Experimental Group and the Control Group in the Post-Test Exam?"

To answer this question, first, two sample t-test was conducted to inspect the difference between the means of the pretest results of the students in the control group and experimental group. For this test, the null hypothesis was there was no significant difference in experimental and control group students' mean scores in pretest that measure their comprehension of instructional design concepts and ICT literacy. The alternate hypothesis there was a significant difference in experimental and control group students' mean scores in pretest that measure their comprehension of instructional design concepts and ICT literacy. Table 2 shows the results of two sample t-test that was conducted to inspect the difference between the means of the pretest results of the students in the control group and experimental group.

The mean score of the pretest for the experimental group was 1.52 and the mean score of the pretest for the control group was 1.42. The standard deviation of the scores of the

Table 1. T-Test for dependent samples for the pretest and post-test scores of the control group and experimental group

Groups		*M*	*SD*	*t*	*df*	*p*
Control group	Pretest	1.42	0.82	- 7.5	30	.000
	Post-test	1.94	0.63			
Experimental group	Pretest	1.52	0.80	-8.5	32	.000
	Post-test	2.82	0.47			

pretest for the students in the experimental group was 0.81 and the standard deviation of the scores of pretest for the students in the control group was 0.85. The significant value was 0.69, which was more than 0.05. So, null hypothesis was accepted. Therefore, there was no significant difference in experimental and control groups students' mean scores in pretest that measure their comprehension of instructional design concepts and ICT literacy. Such findings verify the initial equivalence between the experimental and control groups students in their comprehension of instructional design concepts and ICT literacy.

Furthermore, to answer the second question, two sample t-test was conducted to inspect the difference between the means of the post-test results of the students in the control group and experimental group. For this test, the null hypothesis was there was no significant difference in experimental and control group students' mean scores in post-test that measure their comprehension of instructional design concepts and ICT literacy. The alternate hypothesis there was a significant difference in experimental and control group students' mean scores in post-test that measure their comprehension of instructional design concepts and ICT literacy. Table 3 shows the results of the t two sample t-test that was conducted to inspect the difference between the means of the post-test results of the students in the control group and experimental group.

The mean of the post-test control group was 1.94 and the post-test of experimental group is 2.82. The standard deviation of the post-test control group is 0.44 and the post-test of experimental group was 0.47. The t-value is 6.75 and the degree of freedom is 30. The significant value is .000, which is less than 0.05. So, we reject the null hypothesis. Therefore, there is a significant difference between post-test results of experimental and control group. Such finding proofs that the use of electronic static infographic to support students' learning would have positive impact on developing university students' comprehension of instructional design concepts and ICT literacy.

DISCUSSION

The analysis of the students' scores in the pretest and post-test discovered that students' comprehension of instructional design concepts and ICT literacy had considerably enhanced

Table 2. Two sample t-test for the pretest of the control and experimental groups

Group	M	SD	t	df	p
Control group	1.42	0.85	.41	62	.690
Experimental group	1.52	0.81			

Table 3. Two sample t-test for the post-test of the control and experimental groups

Group		M	SD	t	df	p
Control group	Post-test	1.94	0.44	6.75	62	.000
Experimental group	Post-test	2.82	0.47			

in the two programming classes, for the class with the employ of electronic static to support students' learning and the one without the employing of electronic static infographic to support students' learning. However, the findings of the study showed that traditional face-to-face instruction combined with electronic static infographic to support learning was more useful to improve students' comprehension of instructional design concepts and ICT literacy than relying on only traditional instruction in the instructional design course. The results can be justified from different perspectives. For instance, from the behavioral and cognitive schools perspective, the use of electronic static infographic to support students' learning would provide the students with various opportunities for repetition without information surplus, as a result enhanced retention and comprehension was achieved. Furthermore, improved students' comprehension of instructional design concepts and ICT literacy as a result of using electronic static infographic to support students' learning can be justified through the lens of visual learning theory. For instance, researchers stated that "A long history of visual design theories also support the use of multiple media sources (i.e., text and images) to enhance learning and retention, and accommodate cognitive learning" (Elena Gallagher et al., 2017). Furthermore, the use of electronic static infographic to support students' learning would match various students' learning styles (Apriyanti et al., 2020).

The current findings align with the findings of similar research study that showed the effectiveness of the use of infographics in enhancing students' learning in different majors and on different levels. For instance, Al-Hadad (2018) found that the use of infographics for social studies class has helped to improve the performance of sixth-grade students, where the infographics have increased retention of the information and reduced time for learning for the students. In addition, Alotiabi (2016) found that using instructional infographic method to teach English grammar would improve students' performance in English language compared to the use of traditional instruction methods. Shawoush (2019) also found that using infographic used to teach computer subject would improve school students' performance in computer subject compared to the use of traditional instruction methods.

CONCLUSION

The findings of this research study indicate that the use of electronic static infographic (information graphic) technology to support students' learning is effective in developing university students' comprehension of instructional design concepts. The results of this study suggested that electronic static infographic technology has potential to support students' learning from the perspectives of different theories e.g., behaviorism, cognitivism, and visual learning theory.

The educational institutions should consider the potential of infographic technologies for educational purposes, where educators should be encouraged to adopt the use of infographics to support students' learning in various disciplines in general and in instructional design subject in particular. The use of electronic version of infographic can be facilitated by the popularity of electronic devices e.g., smartphones

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and laptops among university in Arab world, where several research studies have pointed to the popularity of such devices among university students (Alanazi, 2014; Alfawareh & Jusoh, 2014; Al-Emran et al., 2016; Gasaymeh, 2018; Almisad & Alsalim, 2020).

However, further investigation is required to investigate the different applications of various types of infographics in the diverse educational majors. In addition, as a limitation of this study, participants were male undergraduate students. Therefore, future study may include more female and male participants and may be conducted at various educational levels e.g., graduate students and school students.

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