

Effects of Infographics on Student Achievement and Students' Perceptions of the Impacts of Infographics

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Abstract

Infographics, a portmanteau of "information" and "graphics," are used in the current study as an instructional assignment in an introductory curriculum course. This study's goals are to investigate whether the use of infographics results in significant differences in university female students' achievement and to explore the students' perceptions of the infographics' impact. Using a quasi-experimental design, this study was conducted with 165 participants divided into two groups: experimental (N = 83) and control (N = 82). The treatment lasted for 9 sessions each of 2 hours duration. Data were collected using achievement tests and a questionnaire assessing students' perceptions. The results revealed significantly higher achievement in the experimental group than in the control group. Almost 90% of the participants in the experimental group reported that infographics had a positive impact on their intellectual, life skills, and affective development. Conclusions are drawn, and directions for future studies are discussed.

Keywords: infographics, visualization, perception, curriculum.

Introduction

Educational qualification requirement courses can be an unpleasant experience for students in an English literature department. Unlike other courses that involve interpretation, analysis, and reflection, such those focused on poetry, drama and novels, courses in education consist of learning and memorizing concepts, definitions, and names. EDU 306: Principles of Curriculum is an example of this type of unpleasant course. The author of the present study has taught EDU: 306 for seven semesters and is well acquainted with students' evaluation of its content and methods of teaching and learning. During this time, the author has observed that students consider this course to be boring and overloaded with complicated and troublesome concepts. Thus, the author felt obligated to enliven the methods used to introduce the course by engaging students in the learning process in a way that might appeal to their senses and follow the development of 21st century students, who are often referred to in certain studies as "digital citizens" surrounded by communication media, smart phones, applications and information technologies (Islamoglu et al., 2015 .p.33). It is commonly documented in related studies that new technologies have transformed society and that their influence on the daily life activities of individuals have affected students' preferred information formats, leading them to favor "visually appealing information resources with concise textual content" (Brigas & Ramos, 2015; Islamoglu et al., 2015). In a study conducted in 2011, Roehling, Kooi, Dykema, Quisenberry, & Vandlen (2010) stated that this new generation of students has been raised in a "multimedia environment in which they rapidly shift their attention from one source of information or stimulation to another. As a result, these students tend to have a low tolerance for boredom and require high levels of stimulation to remain focused" (p. 2).

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This study implies that "digital age" students require "digital age" learning that involves a visual representation of data to attract their attention (Marabella, 2014, p. 6). Studies that compare visual and verbal communications claim that visual communication is more effective than verbal communication because the human mind is capable of perceiving visual representation "in a short time and in a more efficient and permanent way compared to written or verbal information" (Dur, 2014, p. 40). Visual representation can convey a complex message in a mere snapshot rather than using several pages of explanation to convey the message (Zayan, 2015, p. 31). A relatively new but widespread visual representation element is infographics. The term "infographics" combines the terms "information" and "graphics." An infographic is a composition of concise explanatory text and visual representations that are blended to convey a story-like message that is attractive and easy to understand. The attraction and power of infographics is partly due to the variety of representations that can be used, including pie charts, bar graphs, zoom boxes, histograms, icons, line charts, tree diagrams, and even pictures (Parkinson, 2016, p. 27; Rezaei & Sayadian, 2015, p. 79; Wertz & Saine, 2014, p. 80). The terms "infographics" and "data visualization" are often used interchangeably because of their similarities. "Infographics" and "data visualization" share the same purpose, which is to visually convey data; however, infographics are not identical to data visualization. Data visualization is a technique used to transform raw statistical data into a visual representation. Data visualization alone is not the same as infographics but, rather, a tool used by designers to create infographics. Infographics can convey a certain subject in a story-like presentation using a variety of graphical elements and text to present an introduction, details, and conclusion, whereas data visualization only provides a snapshot of a single moment within the story (Dur, 2014, p. 41; Islamoglu et al., 2015, p. 34). In sum, data visualizations are isolated representational forms, while infographics are powerful standalone representations that convey an entire message quickly and clearly "even without accompanying text" (Davis & Quinn, 2014, p. 16; McDermott, 2014, p. 37).

In the past, only designers and professionals created infographics because they were created using specialized, complicated, and expensive software such as Microsoft Publisher, InDesign, Adobe Illustrator, and Scribus (Guevara & Moore, 2013, p. 12; Lamb, Polman, Newman, & Smith, 2014, p. 28). Currently, because of the advent of web applications, several easy and low-cost or free tools have emerged, many of which can be used without prior training. A literature review regarding websites that can be used to create infographics indicated that 9 websites were commonly recommended: Piktochart; Infogr.am (Guevara & Moore, 2013, p. 13), (Abilock & Williams, 2014, p. 54), (Davis, 2014, p. 17), (Zayan, 2015, p. 31), (Parkinson, 2016, p. 7); Venngage (Davis, 2014, p. 17); Easel.ly (Guevara & Moore, 2013, p. 13); Visual.ly (Davis & Quinn, 2014, p. 17); Canva (Parkinson, 2016, p. 7); Dipity (Abilock & Williams, 2014, p. 54); and Tagxedo and ReadWriteThinks Timeline (Karre, 2015, p. 13). Because of their clarity and illustrative value, infographics are commonly used in news websites, broadcasts, newspapers, weather charts, traffic signs, tag clouds, and subway maps (Davidson, 2014, p. 35; Davis & Quinn, 2014, p. 16; Rezaei & Sayadian, 2015, p. 79).

Because of these outstanding features, infographics may be a promising technique for instruction and could serve a variety of purposes. Lamb and Johnson (2014) proposed five uses for infographics. First, infographics can organize ideas in a useful and coherent manner by visually illustrating key concepts and rearranging ideas. Abilock and Williams (2014) referred to this process as "Crystallizing information" (25). Infographics can also visually display complex relationships. Second, when browsing the Internet, a variety of useful and attractive infographics can be found illustrating biographical, scientific, art and design, historical, and social studies concepts, which demonstrates the power of infographics for explaining complex relationships. Third, infographics can be used to compare information and effectively illustrate the most discriminate features of a topic. Fourth, infographics can make data meaningful by providing analogies, examples, and themes; plain data can be transformed into meaningful information. Elaborating on this use of infographics, writers generally refer to Tufte's phrase "good design is clear thinking made visual" (Rosenberg, 2015, p. 39). The fifth use of infographics is for telling a story in an exciting manner that blends words and pictures (Lamb & Johnson, 2014, pp. 55-57). A story-like presentation of infographics uses an introduction, a plot, and a resolution, mimicking the trajectory of stories, which adds vividness and attracts audiences to infographics. Considering the purposes and benefits of infographics as well as the characteristics of today's students, the author of the present study believes that infographics may be used as a tool to help students comprehend the information provided in a specific course (EDU 306: Principles of Curriculum) and that it would be valuable to investigate students' perceptions of infographics as a teaching and a learning tool.

Literature Review

The term "instructional infographics" emerged in 2014, when reports and studies investigated the efficacy of infographics in an instructional context. Studies revealed that infographics could achieve a variety of instructional objectives. In 2014, Saurbier used infographics to integrate high-order thinking skills in undergraduate leadership instruction and concluded that infographics improved her students' disciplinary competence and enhanced their success skills and creativity (Saurbier, 2014, p. 17). Fowler involved students in creating infographics for science lessons and determined that infographics depicted and adjusted scientific misconceptions; developed high-order thinking skills including analysis, synthesis, and critical thinking; and facilitated the development of creative presentations (Fowler, 2015, p. 44). Meacham conducted a study in 2015 and used infographics in her science class; she confirmed that the students could present complicated processes and concepts and that infographics could be used almost anywhere in instructional design either as a pre-teaching tool or to reinforce certain topics (Meacham, 2015). Subsequent studies ((Fredrick, 2013; Sudakov, Bellsky, Usenyuk, & Polyakova, 2016) have affirmed Meacham's statement that infographics could be used as a starting point for a discussion and as a culminating experience of authentic learning by allowing students to demonstrate their ability to fully comprehend a topic and summarize its central themes in a concise manner. Infographics have been effective when used to teach English grammar to learners of English as a foreign language (Al Hosni, 2016; Alotiabi, 2016; Rezaei & Sayadian, 2015; Vanichvasin, 2013).

Davis and Quinn claimed that infographics can effectively support writing and reading comprehension and can clarify complicated subjects such as science, history, and math while strengthening critical thinking and synthesizing skills (Davis & Quinn, 2014, p. 18). In addition, Dur examined the current and potential expansion of infographics in education and concluded that in addition to their role in improving students' academic achievement, infographics could develop students' life skills and attitudes, such as research, systematic thinking and teamwork skills (Dur, 2014, 48). Infographics can also be used for hands-on learning (Davidson, 2014, p. 37), problem solving, engagement (Meacham, 2015, p. 77), and to enhance students' reflective and creative thinking (Islamoglu et al., 2015, p. 35; Karre, 2015, p. 13). The advantages and benefits of infographics have been noted and documented primarily by librarians and educational practitioners; few empirical studies have examined the impacts of infographics on students' achievement, life skills or affective development. This is one of the first studies to investigate infographics' influence on students' achievement in a course in education and to explore students' perceptions about the use of infographics using scientific methods and validated instruments.

Statement of the Problem

The problems addressed in this study are as follows:

1. Does the use of infographics result in significant differences ($\alpha \leq 0.05$) in students' academic achievement versus curriculum without infographics?
2. What are the perceptions of the participants regarding the impact of infographics?

Method / Research Design

A quasi-experimental two-group pretest\posttest design was used to investigate the impact of the independent variable (using infographics) on the dependent variable, which is achievement in an introductory curriculum course (Principles of Curriculum). However, the descriptive method was used to collect and interpret students' perceptions of infographics.

Participants and Setting

The participants included 165 undergraduate female students enrolled in an English-language program at Al-Imam Muhammed Ibn Saud Islamic University. Students were enrolled in EDU 306: Principles of Curriculum during the fifth semester of their study. Students were preparing to become EFL teachers. The age of the participants varied between 21 and 23 years old. All students were native speakers of Arabic. Participants were enrolled in four sections (341, 342, 343, and 344), and the number of enrolled students in these sections was 42, 39, 43, and 40, respectively. Participants were divided into two groups (sections 341 and 342), and 82 were assigned to the control group; the experimental group included sections 343 and 344 (N=83).

The course analyzed in this study, EDU 306: Principles of Curriculum, introduces students to sophisticated concepts of curriculum and methods of analyzing and evaluating different aspects of a curriculum.

Instruments

Four instruments were used to achieve the purposes of the study:

1) An investigator prepared and validated an "achievement test." The achievement test was used as a pre- and post-test and included 20 multiple-choice questions that each offered four answers for a total score of 20. Students were given 30 minutes to complete the test. Test items were derived from teaching materials. To ensure the validity of the test, a panel of six experts (curriculum specialists) closely examined the test and made recommendations. Questions were adjusted according to specialists' feedback. A preliminary test was conducted with 43 students enrolled in section 347 in the same department and studying the same course; however, these students were not involved in the treatment. The Cronbach Alpha analysis was performed to analyze the reliability of the test items. The Cronbach Alpha values ranged from (0.42) and (0.70), which indicated the internal consistency of the test. The item facility (IF) indices of the test items were between (0.28) and (0.68). Item discrimination analysis was also performed, and the values were between (0.20) and (0.80). The results of the statistical analysis indicated that the test had a satisfactory reliability, facility, and discrimination (statistics of the test items including the Cronbach Alpha values, IF, and item discrimination (ID) are provided in Appendix 1).

2) All study participants were asked to view a Piktochart Tutorial video. The Piktochart website offers a tutorial video on using infographics (<https://piktochart.com/demo-video/>), which was used to introduce the students in the experiment group to the infographic tool used in this study. Although a variety of websites are available to create infographics, "Piktochart" was selected because it meets the requirements of this study. Piktochart offers a free version that provides a variety of presentations, templates, fonts, and images and includes the ability to manipulate colors, sizes, fonts, and images. Piktochart also offers a tutorial video, an easy-to-use toolbar, and a simple drag-and-drop method of creation. Infographics that are created by Piktochart can be saved as a PDF, JPEG, or PNG file or linked, embedded or emailed (<https://piktochart.com/product-features/>) (Abilock & Williams, 2014, p. 54; Ellis-Barrett, 2016, p. 1; Guevara & Moore, 2013, p. 13; Karre, 2015, p. 13).

3) An infographics evaluation checklist was used to evaluate the students' infographics. The checklist was prepared, validated and used by the investigator to evaluate students' infographics and was also used by the students as criteria to adopt while creating their infographics and critiquing their peers' works. Items on the checklist were based on standards of effective outstanding infographics that are commonly cited in related studies (Antonova, 2016; Davidson, 2014, p. 37; Davis & Quinn, 2014, p. 16; Kibar & Akkoyunlu, 2014; Lamb & Johnson, 2014, p. 58; Siricharoen, 2013, p. 173; Siricharoen & Siricharoen, 2015, pp. 562-563). A panel of nine experts that included mass communication and media specialists and curriculum department faculty members examined the checklist items and made recommendations. The final draft of the checklist included 17 items in three categories: information, organization, and aesthetics and utility. Infographics were scored on a scale of 0, 1, and 2 for each item. A score of 2 was granted when the infographic included high-quality features, a score of 1 was granted when the features needed improvement, and a score of 0 was granted when features were not included in the infographic. The entire infographics evaluation checklist is provided in Appendix 2.

4) The study used a questionnaire to determine students' perceptions of the infographics. The questionnaire was prepared and validated and was used to assess participants' feelings and thoughts regarding the infographics as teaching and learning tools. The questionnaire included 19 items with positive statements assessing students' perceptions with respect to three dimensions of infographics' benefits: intellectual (items 1-10), life skills (items 11-15), and affective benefits (items 16-19). Participants were asked to indicate to what degree they agree or disagree with each statement on a 5-point Likert scale (1 = strongly disagree, 2 = disagree, 3 = undecided, 4 = agree, and 5 = strongly agree). Higher scores on the 5-point Likert scale indicated positive perceptions. The maximum possible score on the questionnaire was 95 (a copy of the students' perceptions questionnaire is provided in Appendix 3). The questionnaire items were reviewed by a panel of six experts from the curriculum and instruction field. Pearson's coefficient was calculated to ensure the validity of the instrument. Pearson's coefficient ranged from $r = 0.28$ to $r = 0.87$ and is provided in Appendix 4 (Pearson's Correlation Coefficients of Each Item Degree with the Total Degree). According to Appendix 4, the coefficient correlation of each item was significant at (0.01) and (0.05). The test confirmed that the questionnaire is consistent and valid to be used as an instrument to collect data.

Cronbach's Alpha was used to assess the internal consistency reliability. Values of Cronbach's Alpha ranged from $r = 0.43$ to $r = 0.58$, and the overall Cronbach Alpha was 0.67, which indicates good consistency among the items within each dimension and scale. Appendix 5 provides the Cronbach's Alpha for the questionnaire dimensions and for the entire questionnaire. The questionnaire items were derived from the merits of infographics described in previous studies (Davidson, 2014; Davis & Quinn, 2014; Dur, 2014; Fowler, 2015; Hattwig, Bussert, Medaille, & Bugress, 2013; Islamoglu et al., 2015; Karre, 2015; Lamb et al., 2014; Meacham, 2015; Rezaei & Sayadian, 2015; Rosenberg, 2015; Saurbier, 2014). The present study gained insights from prior studies and explored these claims from the student's perceptive.

Procedures

A pilot study was conducted prior to the original study to ensure the reliability of this study instruments. A fifth semester section of 43 students who were not involved in the original study participated in the pilot study. The primary study began during the second week of the first semester in 2016 and lasted nine weeks. Because a random distribution of participants in the research group was prohibited according to university management policies, the study was conducted on students in their original sections. However, pre-experimental measures were incorporated to ensure the equivalence of research groups for the study. Participants were divided into two groups (Sections 341 and 342); $N=82$ participants were assigned to the control group and were taught using oral lectures, group discussion, worksheets, and PowerPoint presentations that were prepared by the lecturer. Assignments for the control group included writing reports about what the students learned. The experimental group included Sections 343 and 344 ($N=83$ participants). The experimental group was taught using lectures, group discussions, worksheets, and infographics that were prepared by the lecturer. The students' assignments included creating and discussing infographics regarding the next class lecture in their syllabus. Students worked in teams of two or three.

During the first two sessions, the investigator presented infographics on the course subjects to students in the experimental group; students were asked to reflect on the infographics and explain what they learned. The third session was devoted to introducing students to the infographics maker "Piktochart." Students had been previously informed that they needed to bring their smart devices. The Piktochart tutorial video was shown to the students. Students were asked to create a Piktochart account and explore the Piktochart templates and tools. The students were required to drag and drop images; manipulate fonts, images, and colors; and as a final step, save their infographics. Then, the students were asked to practice creating their infographics for their course assignments. The students read the material very carefully and analyzed the information regarding its contents, outlining the data and determining the main theme and how the components related to it. Next, the students were asked to prepare a preliminary paper that sketched out the visual data presentation, including how the information flowed: students delineated separate visual sections for each section of the data and labeled each section. After this step, students were asked to transform the information using Piktochart. Students were instructed to select a layout and background, search for images and icons that fit their purpose, and ultimately, drag the images and icons into the layout and manipulate them. Students were asked to add a very brief explanation and were then reminded that their infographics should be understandable without any accompanying text. Students were then asked to add a title and resources, revise their work, and make any needed refinements. The steps that were followed in preparing the infographics were identical to the steps recommended by the Piktochart tutorials and identified in relevant studies (Meacham, 2015, p. 77). Examples of infographics were displayed, discussed, and evaluated by the students using the infographics evaluation checklist. At the end of the third session, students were given their assignments and the teams were defined. During sessions 4–8, participants worked in teams of 2 to 3 to create and present infographics on the session topic. Infographics were presented, discussed, evaluated, and refined based on the feedback received. The first 25 minutes of session nine was devoted to the achievement test. The test was administered to the participants in both the experimental and the control group as a post-test.

Data Analysis

SPSS V.22.1 (Statistical Package for the Social Sciences) software was used to analyze the data. Multiple tests, including an independent-samples t test, Cronbach's Alpha, and Pearson's Correlation, were conducted. Item difficulty indices and item discrimination indices were also computed. The accepted significance level was determined to be $p < .05$.

Results

Results Related to Question 1

Does the use of infographics result in significant differences ($\alpha \leq 0.05$) in students' academic achievement versus curriculum without infographics? The equivalence of the research groups in achievement was assessed because the random distribution of participants among research groups could not be determined. An independent-samples t test was performed to ensure that there was no significant difference between research groups in achievement. The descriptive statistics of the participants' achievement on the pre-test and t values are displayed in Table (1).

Table 1Pre-test t value and descriptive statistics of the achievement test for the two groups.

Group	N	Mean	Std. Deviation	T Value	Sig Value	Sig Level
Control	82	2.93.	1.472	0.373	0.710	Not significant.
Experimental	83	2.84	1.401			

The results in Table (1) reveal no significant difference between means of the control and experimental groups for the achievement pre-test, which indicates that the two groups were equal in achievement prior to the treatment. At the end of the treatment, the means and standard deviations of the experimental and the control groups' results were computed, and an independent-samples t test was performed between the experimental and control group achievement on post-tests to answer the first question regarding the efficacy of infographics' use on students' achievement. Table 2 provides the results.

Table 2Post-test t value and descriptive statistics of the achievement test for the two groups.

Group	N	Mean	Std. Deviation	T Value	Probability
Control	82	13.40	1.490	14.852	.95*
Experimental	83	16.81	1.461		

*p < 0.05.

Table (2) shows that the computed t value is greater than the tabulated t value, which indicates significant differences (at $\alpha \leq 0.05$) in the total average score of the post-test between the experimental and control groups in favor of the experimental group. The mean of the post-test in the experimental group reached 16.81, and the mean of the control group was 13.40. This result indicated that using infographics significantly improved the experimental group participants' achievement. This result could be attributed to the visual appeal of infographics, which attracted students' attention and facilitated their comprehension. Defining visual tools as *tools for success*, Hyerle (2008) revealed that approximately "80 and 90 percent of the information received by the brain come through the eyes" and that the human brain can absorb "36,000 images every minute" (p. 153). Some neuroscience studies assert that the human mental and visual systems are able to process meaning "in less than half a second" (Holcomb & Grainer, 2006, p. 1631). The simplicity and rapid communicative ability of visual representations enable them to be rapidly comprehended by viewers. In their study on 87 participants, Dowse and Ehlers determined that labels containing text and visual representations (pictograms) were comprehended by 95% of the subjects in contrast to labels that contained mere text, which were interpreted by 70% of the of subjects (Dowse & Ehlers, 2005, p. 63). These results might also be interpreted in reference to the percentage of visual learners, which is estimated to be 65% of the population (Smiciklas, 2012, p. 11). Furthermore, studies have revealed that students of all different learning styles are capable of learning through the use of visual aids (Katsioloudis, 2010, p. 71).

The significant difference in the achievement of the experimental group could be attributed to the high memorability of the learned information, which was visually presented in the form of infographics. It is commonly understood that the visualization of infographics increases the retention of learned content. Yildirim (2016) and George (2013) state that "research has shown that people remember visual representations...more accurately, more quickly, and for a longer period of time" than words alone (George, 2013, p. 187; Yildirim, 2016, p. 107). Zinonyev (2010) duplicated George's study and stated that the visual display in infographics allows individuals to visualize, analyze, and remember the message. Zinonyev justifies his statement and adds that the visual memory of most individuals "is more persistent than verbal or auditory memory." In a study conducted by Vanichvasin in 2013, the results revealed a positive impact of infographics on students' comprehension and retention of information (p.230).

In addition, Bateman et al. (2010) revealed that participants could recall details that were included in visual embellishments after a two-to-three-week gap (2573). Alhosni's (2016) results demonstrated that participants who learned EFL using infographics could recall the information after one week (Alhosni, 2016, p. 232). Furthermore, participants in Yildirim's study believed that the information obtained through infographics was easily remembered and permanent (Yildirim, 2016, p. 102).

The infographics evaluation checklist that was used in this study required that the information presented using infographics was concise and flowed in a coherent and organized manner. Adherence to these two criteria added to the memorability of information and might have influenced the participants' achievement in the experimental group. In a study conducted with 64 participants, Yildirim concluded that "information organized with stronger relationships can be more easily remembered", particularly when "important points are emphasized" (Yildirim, 2016, p. 102). The active learning experience that participants engaged in during the treatment could have contributed to their high achievement. Participants in the experimental group were asked to read the content more than once, analyze the information, filter out irrelevant information, organize data logically, and then sketch the information and represent it visually. This group of students was informed that their work would be presented, discussed, and evaluated by their teacher and colleagues. Therefore, a considerable sense of responsibility was aroused in these students, and they expended more effort to develop their infographics to the best of their ability, which positively influenced their achievement. Spending time working intently and deeply on the syllabus subjects helped the participants to understand the information. The cooperative and collaborative learning procedures used in the treatment may have contributed to the results. Participants worked on their infographics in groups of two or three students who had read and discussed the same subject. This interpretation is consistent with Pisarenko and Bondarev's conclusion that using infographics in a class "guarantees an active acquisition of knowledge...analysis of a studied material, and intellectual activity stimulation" (Pisarenko&Bondarev, 2016). Çifçi investigated infographics' impact on 10th-grade students' achievement in geography and determined that infographics can foster active involvement in the learning process and "lead to permanent learning and high remembering rates" (Çifçi, 2016, p. 163). The results of the present study regarding students' achievement are consistent with results of prior studies (Alotiabi, 2016; Gallicano, Ekachai, & Freberg, 2014; Gareau, Keegan, & Wang, 2015; Al Hosni, 2016; Rezaei&Sayadian, 2015) and indicated that using infographics positively impacts students' achievement. The outcomes of this study also support the claims of prior studies that infographics are a promising instructional tool that could improve students' achievement and capacities (Davis & Quinn, 2014; Dur, 2014; Fowler, 2015; Islamoglu et al., 2015, p. 35; Karre, 2015, p. 13; Saurbier, 2014; Yildirim, 2016; Young & Ruediger, 2016). However, the results of the current study are inconsistent with the results of one study (Lyra et al., 2016) that reported no significant difference between students who used graphic and text and students who used infographics. This study's results are also inconsistent with results of Çifçi (2016) that found no significant difference in achievement between students who used infographics and students who did not use them. The difference in these results may have occurred because the subjects in Lyra et al. (2016) and Çifçi (2016) were passive viewers rather than active participants in the creation of infographics. Therefore, those study participants did not experience active and authentic learning.

Results Related to Question 2

What are the perceptions of the participants regarding the impact of infographics? The results of the students' perceptions questionnaire regarding the impact of the infographics are provided in Table (3).

Because reporting the results for each of the 19 items in table form would make this paper very long, only the results for the subscales are provided here, and the detailed results for the questionnaire items are provided in the appendixes (see Appendix 6 for more details).

Table 3 Results of the Students' Perceptions questionnaire subscales

No	Subscales	Totalsubjects	Mean	Standard Deviation	%	Rank
1	Intellectual	83	4.60	0.232	92%	1
2	Life skills	83	4.51	0.326	90.2%	2
3	Affective	83	4.48	0.392	89.6%	3
	Total	83	4.53	0.236	90.6%	

Table 3 shows that 90.6% of the participants in the experimental group reported that infographics had a positive impact on their intellectual and life skills and affective development.

Of the respondents, 92% reported that the use of infographics had a positive impact on their intellectual development, 90.2% reported that the use of infographics contributed to their life skills development, and 89.6% reported that the use of infographics had a positive impact on their affective growth. According to the participants' perceptions, the intellectual advantages of infographics were the most obvious and were ranked the highest, followed by infographics' contribution to the development of the participants' life skills (ranked 2nd) and the affective impacts (ranked 3rd).

The results provided in Table 3 indicate that a high percentage of students (92%) had positive perceptions regarding the use of infographics and reported that it had a positive impact on their intellectual development. The study participants also indicated that infographics captured their attention, kept them engaged, helped them to easily understand complex information and determine key words and concepts, helped them to filter out irrelevant data, organized information into logical groups, increased their understanding of hidden relationships, facilitated the connection of new information to old information, improved their critical thinking, facilitated retention, and informed the participants about the responsible use of images. The table in Appendix 6 provides the means, standard deviations, percentages, and ranks of items for the students' perceptions questionnaire. Items 1-10 are devoted to assessing students' perceptions regarding infographics contribution to their intellectual development. Percentages of the evaluation of items 1-10 ranged from 89.2% to 94.4%, which indicates that participants perceive infographics as instructive and promising learning tools. The results of this study provide clear support for the results of the few prior studies that surveyed students' attitudes toward infographics, including Gallicano et al. (2014), Matrix and Hodson (2014), Pisarenko and Bondarev (2016), and Yildirim (2016). The perceptions of this study's participants are nearly identical to perceptions reported by Gallicano et al. (2014) where infographics were believed to help summarize and determine important data (Gallicano et al., 2014, p. 8). Participants in Matrix & Jaigris's study believed that infographics enhanced their ability to critically process information and allowed them to filter out irrelevant data and "prioritize some information over the rest" (Matrix & Hodson, 2014, p. 23). In Pisarenko and Bondarev's (2016) study, more than 80% of the surveyed students had a positive attitude regarding the introduction of infographics during the teaching process; respondents stated that infographics contributed to a better understanding of complex information and illustrated the relationships between different elements in a concise presentation. Yildirim conducted a survey of 64 participants' perspectives regarding infographics, and the participants reported that infographics facilitated their learning, enhanced their analysis and synthesis skills, clarified relationships between different concepts, and made their learning more permanent (Yildirim, 2016, p. 99, 106).

Results regarding participants' perceptions of infographics' impact on their acquisition of life skills are displayed in Table 3. Table 3 shows that a high percentage of students (90.2%) reported positive perceptions of infographics and believed that it had a positive impact on their life skills improvement. Participants in the experimental group also indicated that infographics helped them communicate what they had understood to others, improved their presentation skills, and taught them to choose and apply principles of design. Participants also believed that learning about infographics helped them learn how to search the web for appropriate images and acquire teamwork skills. Items 11-16 of the perceptions questionnaire are devoted to assessing students' perceptions regarding infographics' contribution to the development of their life skills.

Appendix 6 indicates that the percentages for items 11-15 ranged from 82% to 94.4% which indicates that participants felt that infographics significantly contributed to the improvement of their life skills. The life skills included in the student questionnaire were practiced during the construction of the infographics. Despite the short duration of the treatment, which did not exceed 9 weeks, participants in the experimental group reported that their life skills were improved. From this perspective, the outcomes of this study align with those of Gallicano et al., whose participants reported that creating infographics enhanced their design skills and enabled them to communicate information in a visual manner. The participants of this prior study also reported that creating infographics improved their research skills because they had to find numerous sources to identify the best information and they were required to judge the credibility of those sources (Gallicano et al., 2014, p. 16). In addition, Young & Ruediger reported similar outcomes in a study published in 2016.

Young & Ruediger (2016) taught 60 undergraduate students how to create infographics and noted that in addition to learning the course content, participants learned skills that were necessary for their personal lives such as presentation, evaluation, and technical skills related to creating a visual presentation. Students' perceptions of infographics' impact on their affective development were assessed through items 17-19 of the student questionnaire.

The results revealed that 89.6% of the participants in the experimental group reported that infographics improved their appreciation for teamwork, fostered their motivation to learn, and gave them more self-confidence in their ability to learn and succeed. Students' positive perceptions were a result of their work in cooperative groups (of two or three students) where they divided tasks and worked diligently on their project, discussing, negotiating, searching, designing, evaluating, and supporting each other during their development and presentation of their infographics to their classmates. This visual and active learning environment that facilitated instant feedback where data were summarized and presented through an organized and coherent manner improved students' motivation to learn. These results align with (Matrix & Hodson, 2014); participants showed "an authentic interest in, and enthusiastic engagement with each other's work" and reported their self-confidence and appreciation of team work and evaluation as "sincerely appreciated and even enlightening" (p. 22). The high achievement in the experimental group might enhance the self-confidence of the members of this group in their ability to learn and succeed. The results of this study support Lyra et al. (2016), who surveyed the perceptions of 27 undergraduate students regarding their enjoyment and pleasure while using infographics and reported a "significant and positive correlation ($p < .05$) between correct answers and the positive self-assessment of enjoyment."

Conclusions

The results of this study indicate that infographics are effective for improving students' achievement in learning course content and that infographics have considerable potential in education to enhance students' intellectual, life skills, and affective development. These outcomes may provide solutions for faculty who teach complex or abstract concepts that are difficult to explain solely using written text and orally presented material because infographics represent alternative instructional tools. This study suggests that infographics are promising instructional instruments that align with the interests and characteristics of digital age students who are often referred to as "digital natives" or "digital citizens" surrounded by technology (Edwards, Edwards, Wahl, & Myers, 2013, p. 4). This study contributes to a growing number of studies that investigate the benefits of infographics. It is hoped that this study will help researchers because it offers new and validated instruments that could be used in future studies. One of the limitations of this study is that the participants were all female university students. Therefore, the results may not be generalizable to other academic levels or genders. Furthermore, the impacts of infographics on students' intellectual, life skills, and affective development were measured by participants' perceptions rather than performance tests. The limitations of this study might provide possible directions of future studies. This study could be replicated using participants from different academic levels and with different courses and subjects. Possible future studies could include experiments that examine infographics' impacts on certain variables, such as higher-order thinking skills, engagement, systematic thinking, information retention, research, teamwork skills and values, motivation, and self-confidence. Students' perceptions of infographics could also be investigated through interviews and questionnaires with open-ended questions, which would provide an opportunity for additional comments to explore dimensions that have not been investigated in previous research.

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Appendix 1

Validity and Reliability: Statistics for the Achievement Test

Item	AlphaValue	SigLevel	IF (%)	ID (%)	Item	Alpha Value	SigLevel	IF (%)	ID (%)
1	0.45	0.05	40	20	11	0.64	0.05	40	20
2	0.69		32	20	12	0.58		36	40
3	0.42		64	60	13	0.46		28	40
4	0.61		60	40	14	0.51		36	40
5	0.50		32	40	15	0.70		36	20
6	0.49		32	80	16	0.43		40	40
7	0.41		68	40	17	0.62		44	40
8	0.62		32	60	18	0.55		40	60
9	0.53		64	40	19	0.68		52	20
15	0.47		28	20	20	0.53		28	60

Appendix 2 Infographics Evaluation Checklist

Aspect	No.	Principles	Yes	Undecid	No
Information	1	The title is clear			
	2	The title is meaningful and fits the content			
	3	The information is accurate			
	4	The information is clear			
	5	The information is concise			
	6	The information is presented using correct grammar and spelling			
	7	Sources are cited			
Organization and Aesthetics	8	The information flows in a coherent and organized manner			
	9	The amount of space is appropriate			
	10	The text contrasts with the background and could be easily read			
	11	Graphics and images are related and clear			
	12	Lines, colors, fonts, and shapes are used effectively			
	13	Elements of the infographics are consistent and appropriate throughout			
	14	The infographic shows simplicity			
	15	The infographic shows creativity			
Utility	16	The infographic is informative and teaches something			

Appendix 3

Students' Perceptions Questionnaire

Dear students,

The researcher is providing this questionnaire to assess how you feel and think about infographics as a teaching and a learning tool. The information that is provided will be confidential and used only for research purposes. The researcher invites you to read the following questionnaire items carefully and provide your opinion. The questionnaire's ratings are from strongly agree (5) to strongly disagree (1).

Thank you for your cooperation,

The researcher

Dear student, please circle the answer that best describes your opinion.

(key: 1 = strongly disagree, 2 = disagree, 3 = undecided, 4 = agree, 5 = strongly agree)

No.	Items	1	2	3	4	5
1	I think that infographics capture my attention and keep me engaged.	1	2	3	4	5
2	I believe that infographics help me easily understand complex information.	1	2	3	4	5
3	I think that infographics enable me to determine key words and concepts in text.	1	2	3	4	5
4	I believe that infographics help me filter out irrelevant data.	1	2	3	4	5
5	I feel that infographics help me organize information into logical groups.	1	2	3	4	5
6	I think that infographics help me to understand hidden relationships.	1	2	3	4	5
7	I believe that infographics help me to easily connect new and old information.	1	2	3	4	5
8	I think that infographics improve my critical thinking.	1	2	3	4	5
9	I believe that infographics make it easier for me to recall information.	1	2	3	4	5
10	I think that infographics inform me about the responsible use of images.	1	2	3	4	5
11	I feel that infographics help me to communicate what I have learned to others.	1	2	3	4	5
12	I believe that infographics motivate me to search the web for appropriate images.	1	2	3	4	5
13	I feel that infographics improve my presentation skills.	1	2	3	4	5
14	I believe that infographics teach me to choose and apply principles of design.	1	2	3	4	5
15	I feel that infographics help me acquire teamwork skills.	1	2	3	4	5
16	I believe that infographics improve my ability to give and receive feedback.	1	2	3	4	5
17	I feel that infographics make me appreciate teamwork.	1	2	3	4	5
18	I think that infographics improve my motivation to learn.	1	2	3	4	5
19	I think that infographics give me more self-confidence regarding my ability to learn and succeed.	1	2	3	4	5

Appendix 4

Pearson's Coefficients for Questionnaire Items

Intellectual		Life skills		Affective	
Item	Pearson's Coefficient	Item	Pearson's Coefficient	Item	Pearson's Coefficient
1	0.31**	11	0.52**	16	0.87*
2	0.28**	12	0.70**	17	0.74**
3	0.55**	13	0.66**	18	0.43*
4	0.62**	14	0.46*	19	0.55*
5	0.41*	15	0.37**		
6	0.47**				
7	0.58*				
8	0.48**				
9	0.43**				
10	0.33**				

Note: * $p < .05$, ** $p < .01$

Appendix 5

Internal Consistency Reliabilities for Questionnaire Dimensions

Scale	Number of Items	Alpha Reliabilities
Intellectual	10	0.49
Life Skills	5	0.43
Affective	4	0.58
Overall Scale	19	0.67

Appendix 6

Results of the Students' Perceptions Questionnaire Items

No.	Subscales	Items	Sum	Mean	Standard Deviation	%	Rank
1	Intellectual	I think that infographics capture my attention and keep me engaged.	83	4.46	0.65	89.2	10
2		I believe that infographics help me easily understand complex information.	83	4.46	0.54	89.2	10
3		I think that infographics enable me to determine key words and concepts in text.	83	4.71	0.50	94.2	3
4		I believe that infographics help me filter out irrelevant data.	83	4.73	0.49	94.6	1
5		I feel that infographics help me organize information into logical groups.	83	4.69	0.49	93.8	4
6		I think that infographics help me to understand hidden relationships.	83	4.69	0.49	93.8	3
7		I believe that infographics help me to easily connect the new and old information.	83	4.30	0.65	86.0	11
8		I think that infographics improve my critical thinking.	83	4.61	0.60	92.2	5
9		I believe that infographics make it easier for me to recall information.	83	4.72	0.45	94.4	2
10		I think that infographics inform me about the responsible use of images.	83	4.61	0.53	92.2	5
11	Life skills	I feel that infographics help me to communicate what I have learned to others.	83	4.58	0.52	91.6	7
12		I believe that infographics motivate me to search the web for appropriate images.	83	4.10	0.83	82	13
13		I feel that infographics improve my presentation skills.	83	4.47	0.59	89.4	9
14		I believe that infographics teach me to choose and apply principles of design.	83	4.72	0.450	94.4	2
15		I feel that infographics help me acquire teamwork skills.	83	4.69	0.46	93.8	4
16	Affective	I believe that infographics improve my ability to give and receive feedback.	83	4.13	0.79	82.6	12
17		I feel that infographics make me appreciate teamwork.	83	4.61	0.51	92.2	5
18		I think that infographics improve my motivation to learn.	83	4.59	0.49	91.8	6
19		I think that infographics give me more self -confidence regarding my ability to learn and succeed.	83	4.57	0.49	91.8	8