EXAMINING THE IMPACT OF STUDENT-CREATED INFOGRAPHICS ON UNDERSTANDING, ENGAGEMENT, AND CREATIVITY

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ABSTRACT

Infographics can improve understanding and enhance critical thinking skills in readers. However, while research has been done on the importance of infographics, a gap exists regarding how creating infographics enhances student engagement and knowledge retention in higher education. Therefore, this study used a mixed-methods approach to analyze undergraduate responses after creating an infographic. Of the 189 students, 71% agreed that creating an infographic helped them retain, examine, and analyze information more thoroughly, and 62% intended to use the infographic process again. These results suggest that it is advantageous to educate students on how to create infographics to learn and convey information.

Keywords: *infographics, data visualization, knowledge translation, online educational resources, ICT, instructional design*

INTRODUCTION

From humble beginnings as crude markings, visual materials have evolved along with technology. Infographics, an abbreviated term for information graphics, are pictures and graphics that strategically tell a story about a set of given data. More recently, infographics have developed from crude markings to print materials, which increased their power to effectively convey complex data. The current rapid, daily influx of digital information makes critical thinking skills important for people making rational decisions based on the data provided to them (Dwyer et al., 2014). Studies demonstrate the need for faculty in higher education to improve the integration of visual materials through assignments that promote active learning (Choi, 2010; Kibar & Akkoyunlu, 2014; Yoon, 2011). Adding infographic projects into instructional design may be a solution to these issues in higher education. Requiring an infographic as part of coursework allows students to learn a tangible skill that will enhance their "communication toolkit" (VanderMolen & Spivey, 2017). Such an assignment additionally facilitates opportunities for students to implement research skills using engaging, technology-based tools.

In recent years, various health service organizations have increasingly used infographics to communicate and summarize critical health information (Muir & Munroe-Chandler, 2020; Royal & Erdmann, 2018). It is well documented that a firm grasp of health information enhances patients' decision-making capabilities, and evidence suggests that presenting information in a graphic format enhances patient understanding (Fant & Choice, 2022; McCrorie et al., 2016). Studies have also identified that infographics are considered more aesthetically appealing than text-only

information (Crick & Hartling, 2015; Martin et al., 2019). Therefore, providing students with an understanding of how to create and when to implement infographics is of critical importance to those preparing for careers in health services, but it is certainly applicable across all disciplines that communicate complex information, such as COVID-19 (Lee et al., 2022; Riggs et al., 2022). In today's environment, with COVID-19 being of utmost concern, infographics play an unprecedented role in informing the world about the pandemic. For example, prominent world and national health organizations (e.g., WHO, ECDC, CDC) use infographics to rapidly disseminate critical COVID-19 information about transmission, protective measures, and treatment development.

While various infographic investigations point to the advancement of critical thinking skills and the engagement realized by utilizing infographics, little is known about students' perceived outcomes after actively creating an infographic. This investigation is the first to examine students' perceived learning outcomes as a result of incorporating infographic lessons into their studies and measuring their engagement and utilization of the infographic process in learning or presenting new material. We begin with a detailed Literature Review examining the origins of infographics and the prominent scholars whose seminal work progressed the field to where it stands today. Next, the literature review findings help inform the Conceptual Framework. The investigation Methods then introduce the context and framework of the study, while the Results, Discussion and Conclusion identify that, although this investigation emphasizes health-related infographics, the findings are relevant and can be easily generalized to other disciplines in higher education.

LITERATURE REVIEW

An appraisal of infographics research would be remiss without a discussion of data graphics and early innovators. As far back as the late 1700s, William Playfair, a political economist, improved upon many original graphical designs (e.g., bar charts, scatterplots, time-series, maps, and multivariate displays). In his book *The Commercial and Political Atlas,* Playfair explained that when compared to numerical tables, graphics better show the shape of the data from a comparative perspective (Playfair, 1801). Laura Tilling, who researched early experimental graphics, described these initial graphs as an immediate check for the accuracy and suitability of the research method, but also as a means to convey complex information in a manner of seconds (Tilling, 1975). Working in parallel was another pioneer of visualization, Johann Lambert, who used novel approaches to present data beyond a relational form with two or more variables, thus creating greater freedom of expression (Gray, 1978; Liu & Yager, 2008). Lambert's and Playfair's work was expanded upon 200 years later in Edward Tufte's influential book, *The Visual Display of Quantitative Information.* Edward E. Tufte, a Yale University professor and prominent writer on the visual display of data and evidence, used the term *graphical excellence* to describe these characteristics. Graphical excellence takes complex ideas and communicates them with clarity, precision, and efficiency in the shortest amount of time using the least amount of space (Tufte, 2001).

Much of the popularity of infographics, even before the age of computers, stems from their use in newspapers. British newspapers *The Guardian* and *The Observer* included data visualizations as early as the 1910s, in the period before color print (Rogers & Anderson, 2013). In the United States, the use of informational graphics exploded in the 1980s as the nation's newspapers embraced computer technology. By the late 1980s, the average newspaper had four infographics per issue (Kenney & Lacy, 1987). Not only did infographics consisting of images, text, and other forms of data help sell newspapers, but it was also demonstrated that they improved recall and critical thinking skills of readers. As early as the 1950s, studies found that a photo with a caption was more effective than text alone in changing reader attitudes (Mehling, 1959) and improving recall (Baxter et al., 1978).

Research investigations began uncovering and assessing other applications for infographics, beyond their use in newspapers. As the landscape of rapid information sharing and the format of STEM-related data has progressively changed, recognizing the diversity in thinking styles is necessary to continue scientific advancement. Williams explains that infographics lead scientists to engage in more relational styles of thinking (Williams, 2002), which may be important for broader participation in science and technology.

According to Hall (1992), while readership in annual reports has been declining, interest in visually presented information has become increasingly favored among young people, who subsequently experience a higher degree of retention and comprehension. Finally, Locoro et al. (2017) concluded that while infographics may be more complex and information dense, the reader's perceived experience with them is better when compared to text-only information.

In the relational and information science realm, visual communication is a prominent element in effective information dissemination (Gallicano et al., 2014). The study found that the inclusion of infographics-related assignments in higher education coursework can assist students in preparing for careers and strengthen their communication and persuasion capabilities. Infographics are a more efficient and impactful means of communication compared to text alone, as they tap into the intricate cognitive processes of visual perception involving various functions of the brain (Otten et al., 2015). Efficient and effective information processing explains why infographics have grown in popularity and, as a result, new forms of infographic applications have emerged in education (Milovanovic & Ivanisevic, 2014). Furthermore, Isamoglu et al. (2015) clarified that knowledge of infographics and their development can be a vital skill for educators from the context of visual literacy. In the health sciences, there is an identifiable gap in faculty education regarding the utility and nuances of infographics as a means for information dissemination (Chicca & Chunta, 2020). Subsequently, there is also a gap in the literature regarding the impressions of students in health sciences and healthcare regarding the effectiveness, utility, and convenience of infographics, both as a visual and a teaching aid.

CONCEPTUAL FRAMEWORK

The study's purpose is (1) to better understand the impact of incorporating infographic lessons in health sciences coursework and (2) to examine students' perceived learning outcomes after creating an infographic. Ruben Puentedura's Substitution, Augmentation, Modification, and Redefinition (SAMR) digital technology model (2014) for evaluating instructional technology was adopted to help develop part of the study's framework. The model is sequential starting with Substitution. Substitution is where technology, such as an infographic, acts as a direct substitute that results in no functional change. An example is an infographic assignment substituting an existing short outline or article review. Augmentation is where technology, such as infographics, acts as a direct substitute resulting in overall improvements to learning. Augmentation uses the power of technology to enhance what can be done on paper or in a standard LMS discussion board. Puentedura asserts that the Substitution and Augmentation levels are comprised of activities that enhance learning, while the following two levels, Modification, and Redefinition, encompass activities that transform learning (Blundell et al., 2022). For example, substituting infographics for text-based documents or PowerPoint assignments leads to the development of questions to learn about students' preferences and perceptions about creating infographics.

Modification allows for tasks to be resigned and Redefinition allows for new tasks to be developed as a direct result of technology. Understanding and teaching creativity with the lens of Modification and Redefinition creates another set of challenges. Defining and categorizing creativity can be challenging, and educators often do not know which assessment to use (Rohwer, 1997). Also, teaching college students to be innovative and make connections requires them to have a thorough understanding of the researched content. From there, creativity can be demonstrated by recognizing information patterns and relationships (Bransford et al., 2000; Sawyer, 2006). Therefore, we were concerned that a Likert scale would not capture the variables of interest related to creativity, such as visualizing or synthesizing knowledge, or the theoretical conceptualization of Modification and Redefinition. For this reason we chose a mixed methods design as an appropriate means to answer the research questions.

METHODS

Research Questions

RQ1: Are there improvements in students' perceived learning outcomes when they create infographics?

RQ2: Do infographics improve students' satisfaction in higher education and increase engagement?

RQ3: Does creating infographics promote student creativity, visualization, and synthesizing of information?

Study Design

This study utilized a mixed-methods approach with a concurrent triangulation design. The combination of quantitative and qualitative methods allows for a more robust analysis as the strengths of each method can account for the other's reciprocal weaknesses (Creswell & Clark, 2017). The mixed-methods approach was appropriate given our expertise in social and behavioral sciences. For the most effective analysis and presentation of the impact of infographics on education, we combined quantitative and qualitative metrics to capture insights on the impact of infographics.

Approval for this investigation was received from the University of Florida Institutional Review Board (IRB). Each participant signed a consent form before participating in the study. Throughout the study, the protection of human rights was upheld, and strict adherence to ethical principles was maintained. The methodology we used was noninvasive and presented minimal or no risks to participants. Furthermore, confidentiality was established and maintained, and informed consent was paper-based and distributed to the participants in person. The electronic questionnaire was compliant with Section 508 and the web content accessibility guideline (WCAG2) standards to ensure it was accessible to any participants with disabilities.

Study Setting and Sample

The study setting was a large, public university in the southeastern region of the United States. Students in a required introductory course on health care systems were invited to participate in the survey. The survey was delivered to four sections of the course after completing an infographic assignment. The students responding to the survey were in their third year of the undergraduate curriculum in the College of Public Health and Health Professions. The total number of students across the four classes was 191. After reading the IRB2 consent form, three students opted out. All those who agreed to participate received an email with the survey. The final participation rate for the survey was 98%. Table 1 displays the characteristics of the 189 participating students. The participants were predominantly female (82.5%), under the age of 25 (99.5%), and non-Hispanic White (59.8%).

Table 1. Participant Demographics

	Frequency (n)	Percent
Gender		
Female	156	82.5
Male	32	16.9
Other	1	0.5
Age		
18-19	23	12.2
20-21	163	86.2
22-24	2	1.1
25-26	0	0
27-28	0	0
29-30	1	0.5
Race/Ethnicity		
Non-Hispanic White	113	59.8
Hispanic/Latino	41	21.7
African American/Non-Hispanic Black	10	5.3
Asian/Pacific Islander	13	6.9
Multiracial	8	4.2
Not Listed	4	2.1
Prefer not to respond	0	0

Instrument

We developed an electronic questionnaire to assess the participants' perceptions of the impact an infographic assignment had on their learning. Face and content validity was assessed by three research experts on the study team. The questionnaire consisted of twelve questions: three pertaining to participant demographics and nine focusing on their experience with infographics (Anderson et al., 2001; Anderson & Lawton, 1992; Phillips et al., 2017). Eight items on the questionnaire used a 5-point, Likert scale allowing for a response of *strongly disagree*, *disagree*, *neutral*, *agree*, or *strongly agree*. The eight questions were:

(1) Given that the infographic process requires the summarization of information and presentation of data on one page, it improved my interpretation of researched material for the assignment.

(2) When comparing infographic to the traditional paper-writing process, the infographic process helped me examine and analyze more thoroughly different points of view related to my

assigned research topic.

(3) Preparing an infographic is more time consuming compared to creating a PowerPoint with the equivalent content development.

(4) The infographic process increased my motivation to learn and made learning more interesting.

(5) As a student, I prefer to read an infographic rather than a plain text document to learn equivalent subject material.

(6) The information on an infographic may be misinterpreted because there is not enough room for written information to expand upon the researched topic.

(7) I remember information that I learned from creating infographics easier than from plain text submissions.

(8) I intend to use the infographic process again in another course.

We used Cronbach's alpha to examine construct validity. The eight items on the questionnaire had a strong internal consistency with a Cronbach's alpha of 0.75. The final question was an open-ended response directing participants to provide specific examples of when creating an infographic either helped or did not help them present information in a more meaningful way.

Mechanics and Scaffolding

We incorporated an infographic project into the curriculum of the undergraduate-level U.S. Healthcare course. The course was designed as a blended learning course that combined face-to-face and online learning. The learning activity required students to create and present their work to an authentic audience. During the first month of the semester, over the course of two weeks, students received a detailed introduction of the use and benefits of infographics, along with numerous examples and instructor-led training on crafting a compelling infographic. The infographic education was specifically divided into three phases. First, the students received a presentation from Rajamanickham's Infographics Seminar Handout, an example used by researchers interested in utilizing infographics in higher education (Çifçi, 2016; Petty et al., 2017; Rajamanickam, 2005) and an infographics video in their learning management system that previews upcoming in-class instruction. Next, the course instructor displayed examples of a high-quality infographic and a mediocre quality infographic, assisted the students in identifying what to avoid when creating one, and conducted a discussion to elucidate comprehension of the best practices and principles associated with infographics (Bonwell & Eison, 1991; Wright, 2016). The final phase was a preassessment of the students. When implementing an infographic lesson in the classroom, doing a preassessment is worth the time to ensure that the students understand infographic design strategies before they start creating an infographic. We found that if they have not learned the design basics, they focus more on creating graphics than on filtering information, establishing relationships, or identifying patterns to create meaningful content knowledge.

The scaffolding, a team-curated infographic encouraging collaborative support while developing and applying a new skill, was executed entirely in advance of the first infographic assignment. As an instructor implementing an infographic assignment, this scaffolding may appear extensive, but the upfront work can and should be done in parallel with focused content delivery that allows for the essential learning objectives for introducing a new learning strategy to be met. In all, to successfully incorporate technology into a lesson, while also increasing student engagement, instructors must garner meaningful involvement through the three phases (Mandernach et al., 2009). Instructor involvement in the discussion demonstrated commitment to the learning process, which was reciprocated by the participating students.

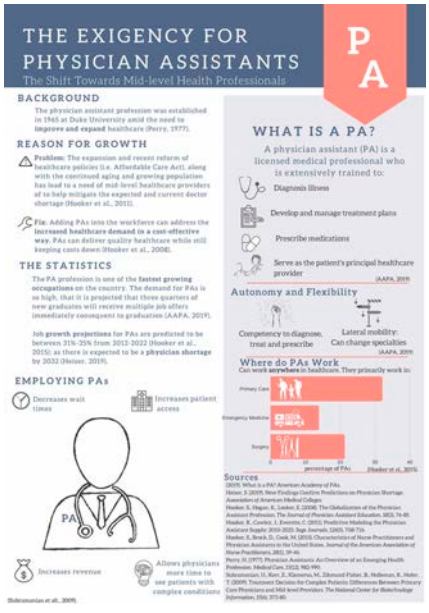
Infographic Platform

For instructors who would like to implement an infographic instructional strategy, setting the foundation for the infographic platform is essential to engaging students. Integrating technology can be challenging, so we found that building on students' experiences and knowledge with Microsoft products, such as Word, PowerPoint, or Publisher, to be helpful as they learn new skills. The instructional strategy foundation is designed to help students become strategic, independent learners, irrespective of the software used to create an infographic. The recommendation for instructors is to suggest free infographic software packages through modeling, given their ease of use with built-in templates, and examples from past students' final products. To avoid apprehension and to foster student independence, we let the students decide the software they wanted to use. Therefore, the students were not

relegated to only Microsoft offerings. Numerous online websites can be utilized as they provide templates to ease infographic development (e.g., easel.ly, infogr.am, Piktochart, Venngage, Visme, and Visualize.me). A primary caveat of these websites is that they are often "freemium," meaning the site offers both free features accessible to all users and premium tools or styles that must be purchased (Kumar, 2014). Participating students were made aware of the freemium concept, so they were not caught off guard if prompted to pay a fee. While students can pay for premium features, it was not required for the assignment.

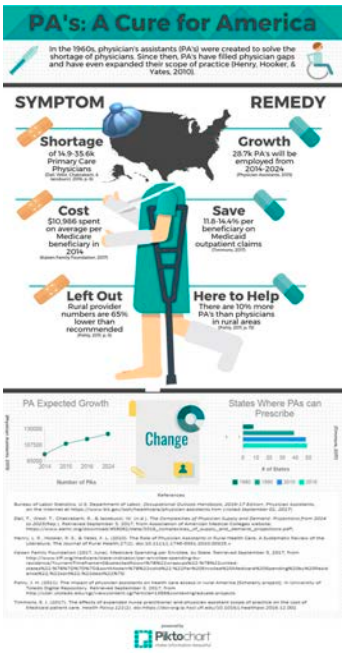
The procedures executed in this investigation suggest that before assigning the initial infographic assignment, students should be provided time to navigate infographic websites independently. Upfront training is vital to the development of high-quality student work given that a complete understanding of infographic fundamentals is required (Wright, 2016). Participating students were provided with examples completed by prior students (Figure 1 and Figure 2) as a means for imparting additional tips and tricks for success. Numerous websites provide examples and video tutorials on how to utilize their platforms, in addition to general tips for constructing a compelling infographic.

Figure 1. Student Example of Infographic.



The Exigency for Physician Assistants. © Brianna Herrin, used with permission.

Figure 2. Student Example of Infographic.



PA's: A Cure for America. © Alice Laflamme, used with permission.

Analysis

To examine the quantitative data, we gathered descriptive participant statistics and illustrated findings in the form of frequencies and percentages. All analyses were conducted using SPSS 25. To analyze the qualitative data, we used an open-coding analytic approach to capture student responses to the open-ended question. One author [CE] independently coded the data to identify emerging themes. NVivo 11 software (QSR International, Inc.) was used to store, organize, and refine emergent themes in the data. After coding the responses, we created notes describing emerging themes. The resulting codes were then independently reviewed by two authors [RK and SL]. Throughout the process, we periodically reviewed, merged, and hierarchically organized the codes to arrive at a final set of themes, and we overcame discrepancies by arriving at a consensus. For the second round of coding, we used a content analysis approach to provide frequencies of themes within the data. To increase the rigor of the findings, we examined the emergent themes for peer debriefing (Creswell & Creswell, 2017) and assessed the content and face validity. Responses were then placed into more than one theme and subtheme as appropriate.

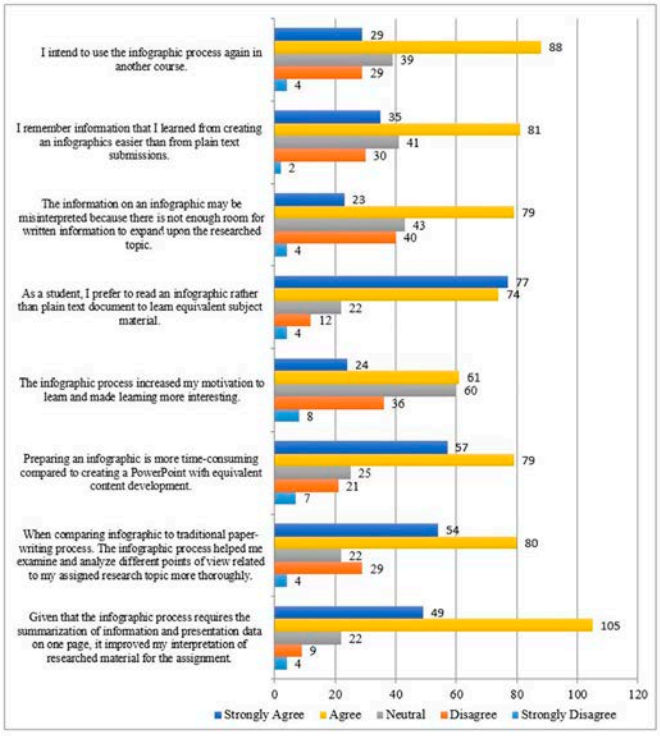
RESULTS

A total of 189 students participated in the study. All 189 students responded to the multiple-choice questions, although 3 of those 189 students did not respond to the open-ended question. The numeric distribution of questionnaire item responses is illustrated in Figure 3. Most respondents stated that they *strongly agree* or *agree* that they would use the infographic methodology again in another course (117 or 61.9%). When asked if students would remember information that they learned from creating an infographic easier than from plain text, 81 (42.86%) *agreed*, 29 (18.52%) *strongly agreed*, 29 (15.87%) *disagreed* and 4 (1.06%) *strongly disagreed*. An overwhelming number of students either *agreed* or *strongly agreed* to prefer reading an infographic rather than plain text (151 or 79.89%). Further, when questioned if the information on an infographic can be misinterpreted due to limited space for text, 44 (23.28%) *strongly disagreed* or *disagreed*, and 102 (53.97%) *strongly agreed* or *agreed*.

Students were additionally asked to rate if the infographic development process increased their motivation to learn and 8 (4.23%) reported that they *strongly disagreed* and 36 (19.05%) that they *disagreed*. Conversely, 61 (32.28%) of students indicated that they *agreed*, and 24 (12.7%) *strongly agreed*. Regarding time management, when students were asked to compare the time required to complete an infographic compared to the time to complete a PowerPoint, 58 (14.8%) *disagreed* or *strongly disagreed* that developing an infographic is more time consuming than PowerPoint. By contrast, 136 (71.9%) *agreed* or *strongly agreed* that infographic development is more time consuming than the equivalent content development.

When students were asked to compare infographics to the traditional paper-writing process and whether the infographic process helped them examine and analyze different points of view related to the assigned research topic, the majority *agreed* (80 or 42.33%) or *strongly agreed* (54 or 28.57%). Finally, when asked if the infographic process had improved their interpretation of researched material for the assignment, 105 (55.56%) and 49 (25.93%) of participating students *agreed* or *strongly agreed*, respectively.

Figure 3. Numeric Distribution of Questionnaire Responses



Following content analysis, three major themes emerged that could be broken down further into subthemes. The three overarching themes included negative, positive, and neutral comments regarding the use of infographics for higher education. Table 2 presents an overview of the themes and subthemes. The negative theme consisted of 19 comments, the positive theme of 128 comments, and the neutral theme of 39 comments. After analyzing the comments from the open-ended question responses (N=186), four negative and seven positive subthemes emerged.

Of the negative subthemes, 13 remarks focused on the idea that infographics are time consuming and challenging to make. Another subtheme, which consisted of 16 comments, is that infographics were difficult to create. Lastly, of the negative subthemes, 16 students indicated that the process of creating an infographic was negative due to group difficulties. From the positive theme, a subtheme consisting of 15 comments emerged expressing the versatility of infographics and how they are relevant in other aspects of students' lives. A total of 43 comments formed a subtheme in which students expressed that infographics are visually appealing while another, with 53 comments, indicated that

infographics were easier to understand than other formats for presenting the information. Finally, of the positive subthemes, 64 student comments alluded to a deeper understanding that occurred because of learning through an infographic. The final theme consisted of 39 comments that contained a neutral sentiment towards infographics. Direct student comments are provided in Table 2 as examples of each theme and subtheme that was identified.

Table 2. Qualitative Response Themes

Themes	Subthemes	Example	Number of responses in this subtheme
Negative	Creation Difficulty	It was frustrating to me all the hard work I put into it, to get critiqued on the fact that my color scheme was not correct rather than being graded on the information itself.	16
	Strict Grading	I loved the opportunity to be creative, but the grading was quite strict.	4
	Aesthetics > Content	I found myself more focused on the aesthetic of the infographic and was worried about the correct use of contrasting colors rather than the material.	10
	Time Consuming	I spent way more time designing my infographic than researching and analyzing the topic.	13
		TOTAL STUDENTS THAT RESPONDED NEGATIVELY	**19**
Positive	Condense Information	I felt like it was a lot easier to condense and pick what I thought was important to include versus including all the information I find like I would in an essay.	53
	Visual Appeal	I enjoyed being able to visually see information in an aesthetically pleasing way.	43
	Creativity	Instead of the traditional research paper, I was able to gather my data and allow my creativity to run free by incorporating graphs and pictures to represent my information.	38
	Increase Understanding	Infographics also helped me visualize my information altogether to create a clear argument, which in turn helps the viewer to better understand the information being expressed.	64
	Accessible	Infographics were an interesting way for me to make an important message accessible and promote public health to anybody.	15
	Useful	I found this to be useful because it synthesized the information and emphasized the key points.	72
	New Skill	The skills I learned when completing the infographics can be easily transferred to the posters and presentations that are required in the honors program.	39
		TOTAL STUDENTS THAT RESPONDED POSITIVELY	**128**
Neutral	Group Difficulty	I also wasn't a huge fan of being assigned to a random group and then immediately starting an infographic.	16
	Creativity	I prefer not to do it with group projects because different style do not always mesh well graphically. It also helped me implement creativity in concepts that do not usually promote creativity.	19
	Visual Appeal	I understand the purpose of infographics, and I do think they filter information, but for the purpose of this class/my intended career path I did not find it helpful.	9
		TOTAL STUDENTS THAT RESPONDED NEUTRALLY	**39**

DISCUSSION

The purpose of the research study was to uncover students' perceived learning outcomes, satisfaction in higher education, and engagement when creating an infographic. The results of this study indicate that student understanding of complex material is enhanced by the execution of an infographic assignment. Approximately 80% of the students preferred reading content delivered via an infographic, with 61.4% of students indicating that infographics made information easier to remember when compared with traditional methods (e.g., reading text). Further, open-ended questions successfully expanded our understanding of students' perceptions of the infographic process. It is clear that incorporating multiple dimensions of learning and utilizing evolving techniques is of the utmost importance in higher education.

Of the 189 questionnaire responses, the majority were categorized in the Positive theme. A Positive subtheme indicated that students felt infographics would be helpful in academic coursework, as well as other aspects of their lives. Supplementary pilot studies should be conducted to further address this concept. The emergence of another Positive subtheme, which indicated that students find infographics appealing, can be used to understand the identification of the additional subthemes of Engaging and Easier to Understand. Quantitative findings further support that the infographic process may be more beneficial to enhancing critical thinking when compared with traditional methods. As indicated by approximately 70% of the students, the infographic process encourages students to deeply examine and analyze different points of view. Infographics are developed by analyzing raw data to uncover patterns that can translate to a visual whole, which can help improve interpretation skills. This process may be linked to student responses acknowledging that infographics are easier to understand than other traditional information-sharing methods, but also why students gained a deeper understanding of the content when compared with a typical learning activity.

As voiced by 13 comments in the Negative theme, and the 136 (71.9%) students that *agreed* or *strongly agreed* to the quantitative question regarding time management, creating infographics can be very time consuming. However, over half (61.9%) of the students indicated that they intend to use infographics again in another course suggesting a strong willingness to learn and overcome the upfront time barrier. Additionally, many higher education students today have grown up with technology and can be described as digital natives (Janzen et al., 2012; Van Eck, 2006). These students are now accustomed to technological advances allowing them to quickly learn a new digital application. Interestingly, approximately 11% of students did not find the infographic process to be a motivational tool. As such, the infographic development process and motivation may not be mutually exclusive. Personality, perspective, background, culture, and experience can all impact motivation to learn (Blumenfeld et al., 2006; Lambert, 1973). Given this, instructors of higher education must emphasize the importance of gaining new technical skills, as students may be reluctant and unwilling to recognize the relevance of such an activity. The frustration that results from the infographic learning process may present from students who believe that the project was not useful or helpful in their education, as indicated by four student responses. In order to implement a new learning activity with technology, instructors must prepare for rebuttal. Encouraging students to become actively involved in their learning, although it may require them to learn skills outside of the scope of their coursework, will be vastly beneficial in the long term.

Limitations and Further Research

While this study displayed numerous strengths, it also has inherent limitations. First, the study was cross-sectional in design. The study population was limited to participants from one undergraduate-level Introduction to U.S. Healthcare course and therefore the study is limited in generalizability (i.e., only to similar universities and programs in health administration) and by sample population (e.g., limited racial/ethnic diversity). The study was exploratory in nature, which contributed to the small sample size, and thus necessitated that descriptive analysis be performed. Additionally, all answers to the questionnaire were self-reported. Therefore, the results are subject to bias and should be treated accordingly. To overcome these limitations, the study methods are being replicated at additional academic institutions, amongst various undergraduate and graduate-level courses. Broadening the scope of the investigation will

afford further insight into and understanding of the generalizability of the observed results as well as the transferability of the infographic process to alternative disciplines.

Examining the information gained and perspectives held by students participating in the infographic process is critical to understanding the impact of infographic utilization in higher education. By nature, an infographic should enhance the consistency, quality, and creativity of student work, thus, making these characteristics important to quantitatively and qualitatively assess (Dur, 2014). Infographics are an excellent way to visualize data and improve critical thinking skills (Hart, 2013; Jaleniauskiene & Kasperiuniene, 2022) and can be utilized to address repetitive questions about technical issues and web accessibility. Further investigations should be conducted with varying sample sizes and among a variety of course disciplines outside of health care or public health to best determine the correlation between observed results. To enhance the value of this instructional technology in the elearning community, further research must investigate the potential infographics have to improve students' critical thinking and reasoning skills. Future studies to evaluate the effectiveness of using infographics in the classroom should implement a valid survey instrument. The inclusion of infographics in public spaces should also be evaluated in the future to assess their impact on attitudes to and beliefs of content-specific information. Additionally, the impact of infographics on health information dissemination and reinforcement should continue to be researched.

CONCLUSION

The results of this investigation indicate that, when implemented systemically with instructional scaffolding in an undergraduate Introduction to U.S. Healthcare course, students hold a generally positive outlook towards the use of infographics. Students reported a deeper understanding of presented content and identified as being engaged for longer periods when compared to other, traditional learning techniques. Improvements were reported in students' perceived learning outcomes when they created infographics and in their satisfaction with higher education and overall course engagement. In all, this study provides a more holistic understanding of the infographic medium, which facilitates an alternative to traditional learning through which students can establish concept connections, classify and filter information, construct relationships, and enhance overall learning.

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