The Impact of Decorative Images on Student Performance: A Two-Year Study of Online Library Modules

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During a two-year period, over 1,900 undergraduate students completed a version of an online asynchronous library module either with or without decorative images. Two instruction librarians compared quiz scores and affective feedback from both versions to determine the impact decorative images had on student performance and analyzed the results through the lenses of multimedia and user experience studies. The study finds that decorative images have little impact on student performance and expounds on how these findings impact design concerns of future online library modules.

Introduction

Academic librarians have been increasingly tasked with creating asynchronous online tutorials and modules as part of their instruction portfolio over the past few years, and this trend has continued because of changes in higher education brought on by the COVID-19 pandemic. Although many librarians are skilled in-person teachers, developing asynchronous online instruction modules poses a unique set of considerations that may be new to many librarians.

One particularly challenging consideration for librarians is the inclusion and use of images, particularly decorative images.

Decorative images are defined as neutral images that are not directly relevant to an essential learning goal of the corresponding instruction content.[1] The use of decorative images is often a topic of conversation at conferences, on twitter, and during online module development meetings. Proponents of decorative images often see them as ways to make asynchronous modules look more interesting or visually appealing to students. Opponents of decorative images, on the other hand, point to potential accessibility concerns.

The authors wanted to better understand the impact of decorative images on student comprehension of library literacy concepts and skills taught via an asynchronous online learning module. The present study was designed to reveal the impact decorative images had on the ability of students in an undergraduate research program to complete asynchronous learning modules. The study of the relationship of decorative images and online learning is also novel

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in librarianship, and the authors hope this study contributes to the growing awareness and best practices for supporting online learners.

Literature Review

The literature around decorative images and online learning intersects across multiple areas of study. The primary intersections relate to research in multimedia studies, scholarship of teaching and learning, user experience, and heuristics.

Cognitive Load Theory

Multimedia research has established that people can learn better from words and images together.[2] However, the overuse of images can create a strain on students' cognitive load. Cognitive load theory (CLT) refers to the amount of effort and working memory required to process and learn a concept.[3] If a concept or task requires too much effort or working memory, then learning will be hampered.[4]

Cognitive load can be further defined in three categories, as explained by Ton de Jong:

> *Intrinsic cognitive load* relates to inherent characteristics of the content to be learned, *extraneous cognitive load* is the load that is caused by the instructional material used to present the content, and finally, *germane cognitive load* refers to the load imposed by learning processes.[5]

All categories of cognitive load express the level of effort required for the acquisition, storage, and use of biologically secondary information.[6] Biologically secondary information is best understood in comparison to biologically primary information. Biologically primary information is information or skills that can be learned without explicit instruction, such as a child learning to walk or learning the language spoken at home. Biologically secondary information, on the other hand, is information or skills that learners must make a conscious effort to learn and is received via explicit instruction, such as a parent teaching a child how to ride a bike.[7]

While de Jong argues that cognitive load is difficult to measure accurately, he discusses the recommendations that come from CLT: "present material that aligns with prior knowledge of the learner (intrinsic load), avoids non-essential and confusing information (extraneous load), and stimulates processes that lead to conceptually rich and deep knowledge (germane load)."[8]

To put CLT in a library instruction context, imagine a student in their first semester of college who needs to complete an online tutorial about using the library for basic research. The student is coming in with very little prior knowledge about how academic libraries work, so the intrinsic load will be higher for this student than for a student who has used the library before. The tutorial is accessed through a simple, user-friendly module on the learning management system Canvas; however, the student has never used Canvas before, resulting in an added extraneous load as they navigate through the tutorial. While the student completes the tutorial, they learn and create memories and schemas around how to use the library for research. This act of learning and creating long-term memories around instructional content is considered to be the germane load.

Extraneous cognitive load is of interest to librarians designing instructional content, particularly asynchronous online modules, because extraneous cognitive load is content that is not necessary for learning and that can be changed or adjusted.[9]

Richard Mayer and Roxana Moreno state that while meaningful learning requires a heavy amount of cognitive processing, instructional designers can mitigate this by designing material in ways that minimize any unnecessary cognitive load.[10] Gary Morrison and Gary Anglin suggest that providing examples, using a combination of visual and verbal aids rather than just one or the other, and providing interactivity are ways to mitigate cognitive load.[11] Findings from Mayer and Moreno also suggest that ways to mitigate cognitive overload are by aligning words with pictures, eliminating redundancy, and weeding out extraneous materials.[12]

Decorative Images

Decorative images inhabit a precarious position between multimedia learning theories and cognitive load theory, in part because of their relationship with the instruction content. Mayer defines types of images used in online learning as instructive, seductive, or decorative.[13] Instructive images are relevant to the learning goals and are directly related to the concepts being taught.[14] Seductive images are highly interesting but not directly relevant to the lesson. Decorative images are neutral material and are not directly relevant to the essential learning goals.[15] Shigeko Takahashi distinguishes instructional and decorative images as a difference of function with the latter providing an aesthetic experience.[16] Sascha Schneider et al. also defines decorative images as "pictures which do not provide information (or at least no learning-relevant information) but are included to enrich learning materials with pictures."[17]

It is important to note that the distinction between Mayer's definition of decorative and seductive images is often blurred in the literature. Some studies use the term "decorative image" to mean aesthetically pleasing and interesting, which is closer to Mayer's definition for seductive images.[18]

The impact of decorative images on learning is varied in the literature.[19] Alwine Lenzner, Wolfgang Schnotz, and Andreas Müller found that decorative images neither harm nor benefit the learning of seventh and eighth grade students as compared to instructional images.[20] Jennifer Wiley et al. found that college students did not hold expectations that decorative images would improve understanding.[21] Looking deeper into subtypes of decorative images, Sascha Schneider, Steve Nebel, and Günter D. Rey split decorative images into the subcategories of positive (conducive), negative (seductive), learning-context, and leisure-context, and found that positive and learning-context decorative images improve learning.[22] Additionally, Schneider et al. found that decorative images designed with human characteristics have a positive impact on learning processes.[23] Further research into the placement of decorative images that show either emotionally positive or emotionally negative decorative images by Maria Mikheeva et al. found that viewing positive images before negative images in a course results in enhanced learning at the beginning, while viewing positive images after negative images in a course decreases extraneous and intrinsic cognitive load toward the middle of the course.[24]

However, Allison Jaeger and Jennifer Wiley found that undergraduate students experienced poor metacomprehension, the ability for an individual to predict how well one will perform on a test after reading a text, in the presence of decorative images.[25] Halszka Jarodzka et al. found that while expert learners can differentiate between stimuli in images and determine the relevant information, novices may be distracted and unsure, and may retain incorrect information from images.[26] Additionally, Sascha Schneider et al. discovered in 2020 that university students who watched a video with decorative images performed worse than students who watched a video without decorative images. However, the same

study found that students shown decorative images during the video and also during the post-video survey were found to learn more than those without decorative images due to a memory cue effect.[27]

A theory called the *seduction effect* has been explored to explain why decorative images may harm student learning. The seduction effect is the impact an image or text has on a learner's ability to process information as deeply as should be expected.[28] The possible reasons why the seduction effect can take place are described as diversion, disruption, and distraction.[29] Jennifer Wiley defines each possible reason as:

- Diversion: the presence of an irrelevant image undermines learning by giving the reader a misconception about the true purpose of a passage.
- Disruption: the presence of additional information prevents the reader from building a coherent mental model from the text.
- Distraction: limited attentional mechanisms are responsible for poor learning when interesting-but-irrelevant images are presented alongside […] texts.[30]

While there are varying levels of support for each possible reason, the seduction effect is often considered the reason why decorative images may inhibit learning in some contexts.

Student Expectations & Behavior

Although the literature is split on the impact of decorative images on student learning, research in learner expectations and online behavior provides additional insights on the impact of decorative images.

User experience studies indicate that online decorative images may be ignored by learners. Eye tracking user studies from the user experience firm Nielsen and Norman report that some images, particularly "big feel-good images that are purely decorative" are "completely ignored" by users.[31] They found that users pay attention to "information-carrying images" that show relevant content to the task at hand.[32] Jakob Nielsen and Kara Pernice state that people ignore images for a variety of reasons, including when they are of poor quality or low contrast, but also when they are not related to content on the page, if they are boring, or if they are generic and look like stock art.[33] Nielsen and Pernice categorize unhelpful images as being obstacles.[34]

Although user experience studies indicate that decorative images may be ignored, users may have the expectation that decorative images are helpful to their heuristic or learning process. Michael Serra and John Dunlosky found that students reading text-only materials or text with photographs unrelated to the topic performed equally lower than students reading text with diagrams related to the topic.[35] However, the text-photograph group's metacomprehension scores were just as high as those of the text-diagram group. This difference indicates that students overrelied on a multimedia heuristic which "inappropriately biased their judgements in a situation—the photo group—where multimedia did not boost test performance."[36] Lenzner, Schnotz, and Müller found a similar heuristic in their 2013 study.[37]

Centering this study around extraneous cognitive load is important as this type of load, or content, is easy to change or modify depending on how it affects student performance. The authors decided that decorative images, as defined in the literature, serve as an ideal type of extraneous load to study due to their prevalence in asynchronous modules. The literature on the impact of decorative images in learning, user experience, and student expectations provides a helpful lens to interpret and discuss results.

Background

The study took place at the University of Michigan in Ann Arbor, Michigan. The University of Michigan is classified as a "R1: Doctoral University" according to the Carnegie Classification of Institutions of Higher Education, and has an undergraduate enrollment of over 30,000 students.[38] The study focused on a population of students enrolled in an undergraduate research seminar during 2018 and 2019.

The seminar was an optional, year-long research experience for early career undergraduate students consisting primarily of first- and second-year students as well as some transfer students. Students enrolled in the seminar received one to four general elective credits, and the seminar was open to students from all of the University of Michigan's schools, departments, and majors. Students were required to conduct research for up to twelve hours per week with a faculty member and attend a weekly seminar where they learned new skills related to scholarship and research.

Library Instruction & Asynchronous Modules

The undergraduate research seminar had a long-standing relationship with the University of Michigan Library, where librarians would provide workshops about library research at one of the required weekly seminars in the fall semester. In-person library instruction was replaced by asynchronous modules via the learning management system Canvas in 2017 as a pilot, which was fully converted in 2018.

In 2018 and 2019, students were required to complete three asynchronous online modules to learn about library research and information literacy. The present study focused on one module called "Reading a Scholarly Article," which consisted of two sections. The first section included two content pages introducing the topic, one video outlining how to read a scholarly article, and one graded quiz that served as a comprehension check from watching the video. The second section provided information on common parts of a scholarly article (e.g., abstract, methods) and walked students through a sample article. The second section included eleven content pages, four ungraded practice opportunities related to the sample article, and one graded cumulative quiz.

Methodology

The study population consisted of 1,941 students enrolled in an undergraduate research seminar during the fall semesters in 2018 and 2019. The students consisted primarily of first- and second-year undergraduate students along with some transfer students. The authors did not gather nor analyze any demographic or academic information about the population for this study.

Module Versions

The authors created two versions of the "Reading a Scholarly Article" module to test the effect of decorative images on student quiz performance in both 2018 and 2019. Both versions were completely identical in regard to the information presented and the number of content pages, videos, ungraded practice opportunities, and graded quizzes. The only difference was the inclusion or exclusion of decorative images in the eleven content pages in the second part of the module.

The version containing decorative images was designated as the *images version* and contained nine decorative images. The version without decorative images was designated as the *text-only version* and contained no decorative images.

Students were randomly assigned either an images version or a text-only version of the module and were required to complete the module for their seminar. Students completing the images version viewed content pages that included both text and a decorative image, while students completing the text-only version viewed content pages that only included text. Figure 1 demonstrates the content page "Abstract" that contains an image of pages from a book, and figure 2 demonstrates the content page "Abstract" that does not include an image (figures 1 and 2).

FIGURE 1
Content Page from the Images Version

Article Section: Abstract

The first step in reading a scholarly article is to read the abstract or summary of the article. Abstracts are always found at the beginning of an article and provide a basic summary or roadmap to the article.

Take a few minutes to carefully read the abstract of the practice article. Note that the abstract is not formally labeled "abstract" but is called "background and aims." Any summary at the start of an article is considered the abstract.

The abstract should always be read first to make sure the article is relevant to your topic. However, reading the abstract should never replace reading the entire article as the abstract is too brief to be used to fully understand the article.

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FIGURE 2
Content Page from the Text-Only Version

Article Section: Abstract

The first step in reading a scholarly article is to read the abstract or summary of the article. Abstracts are always found at the beginning of an article and provide a basic summary or roadmap to the article.

Take a few minutes to carefully read the abstract of the practice article. Note that the abstract is not formally labeled "abstract" but is called "background and aims." Any summary at the start of an article is considered the abstract.

The abstract should always be read first to make sure the article is relevant to your topic. However, reading the abstract should never replace reading the entire article as the abstract is too brief to be used to fully understand the article.

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Decorative Images

The authors chose images that did not have a clear instructional purpose nor were intended to be visually interesting or distracting, following similar definitions of decorative images found in the literature.[39] Additionally, the chosen images fit the definition of online decorative images in user experience studies, as the authors considered them to be generic stock art images.[40] The authors did not control for factors such as images containing humans or human characteristics, nor did they break the images down into particular subcategories as done elsewhere.[41]

Using the definitions found in the literature, the following criteria can be applied to images that were selected for this study:

- The chosen images appear to be a generic image that would be considered stock art.[42]
- The image does not contain any information that is necessary for the student to view or comprehend in order to understand the content of what is being learned.
- The image does not explicitly convey a message, symbol, or attribute that may distract a learner, for either positive or negative reasons
- The image is related to the content being taught

For instance, the image of pages from a book in figure 1 was selected from a gallery of stock art, does not contain any information related to understanding or reading an abstract, does not contain entertaining information (unlike a meme), and is related to the concept of abstracts since an abstract is located on a page. All images used in this study can be found in appendix A.

Measuring Student Performance

The authors assessed student performance with a cumulative quiz of eight questions posted at the end of the module. An additional quiz that evaluated students' comprehension of an instructional video early in the module was excluded from the study.

The cumulative quiz included three questions related to identifying parts of a sample scholarly article and five questions related to concepts taught in the module. The conceptual questions were directly related to content pages that used decorative images. For this reason, the authors analyzed both the cumulative quiz scores and an adjusted score consisting of the five questions that directly related to the use of decorative images. Quiz questions can be found in appendix B.

Students were required to score 100 percent on the cumulative quiz to successfully pass the module and were allowed unlimited attempts. The authors isolated each student's first quiz attempt to evaluate student performance, and subsequent attempts were not evaluated.

Affective Survey

An affective survey was conducted for students enrolled in 2019 to measure their perceptions of each version of the module. All students received the same questions but were not required to answer any of them. Participants answered the affective survey immediately after completing and passing the cumulative quiz. The following affective questions were used:

Q1: How long did it take you to complete the module?
Q2: How much information presented in this module was new to you?
Q3: How challenging was it to complete this module?
Q4: How clear was the information presented?
Q5: How impactful were images in helping you successfully complete the module?

Canvas

The authors used the learning management system Canvas to build and administer both versions of the module, the graded cumulative quiz and the affective survey to students. Canvas was the learning management system already in place for the seminar when library instruction moved online, which is why it was chosen as the delivery system for all aspects of this study.

Although Canvas is relatively easy to use for implementing asynchronous modules, there are limitations to using it to accurately track the amount of time students are on it. For instance, if a student works on a module for thirty minutes, leaves for an hour lunch but keeps the module open on their computer and then finishes the module in thirty minutes after lunch, they could be recorded as taking two hours rather than the actual one hour they spent on the module. Due to this potential issue, the authors decided it would be more accurate to ask students about their perception of time (Q1) rather than looking at any time-related data generated from Canvas.

Statistical Analysis

Student online module quiz scores were analyzed by determining the mean, standard deviation, and number of scores and then tested via an unpaired t test using the software R Studio. The analyzed data was then compared within their respective year to test null hypotheses A and B:

- Null Hypothesis A: The mean cumulative quiz scores will be equal between the images and text-only versions of the final quiz for the module.
- Null Hypothesis B: The mean adjusted quiz scores will be equal between the images and text-only versions of the final quiz for the module

Student affective survey feedback in 2019 was aggregated and analyzed with a chi square test using the software R Studio to test null hypothesis C:

- Null Hypothesis C: The distribution of the affective feedback results will be the same between the images and text-only versions of the survey for the module.

A significance level (p-value) of 0.05 was used to determine if any differences in quiz scores or affective feedback were statistically significant.

Results

In the fall of 2018, 927 students completed the online module; 470 completed the images version and 457 completed the text-only version. The mean scores on the cumulative quiz for the images and text-only versions were 6.4681 and 6.5456, respectively, and 4.4915 and 4.5197 for the adjusted score. The p-value for these differences for the cumulative and adjusted scores were 0.3578 and 0.5858, respectively, indicating that differences were not statistically significant. The 95 percent confidence interval of the difference in cumulative scores and adjusted scores ranged from -0.243 to 0.088 and -0.130 to 0.073, respectively (figures 3 and 4).

FIGURE 3 **Cumulative Quiz Scores 2018**		
	Images (n = 470)	**Text-Only (n = 457)**
Mean Score	6.4681	6.5456
Standard Dev	1.3225	1.2394
95% Confidence Interval	(-0.243, 0.088)	
p-value	0.3578	

FIGURE 4
Adjusted Quiz Scores 2018

	Images (n = 470)	Text-Only (n = 457)
Mean Score	4.4915	4.5197
Standard Dev	0.8337	0.7372
95% Confidence Interval	(-0.130, 0.073)	
p-value	0.5858	

In the fall of 2019, 1,014 students completed the online module with 603 completing the images version and 411 completing the text-only version. The mean scores on the cumulative quiz for the images and text-only versions were 6.4303 and 6.3901, respectively, and 4.4975 and 4.4562 for the adjusted score. The p-value for the differences for the cumulative and adjusted scores were 0.6292 and 0.4123, respectively, indicating that differences were not statistically significant. The 95% confidence interval of the difference in cumulative scores and adjusted scores ranged from -0.123 to 0.204 and -0.058 to 0.140, respectively (figures 5 and 6).

FIGURE 5
Cumulative Quiz Scores 2019

	Images (n = 603)	Text-Only (n = 411)
Mean Score	6.4303	6.3901
Standard Dev	1.2770	1.3393
95% Confidence Interval	(-0.123, 0.204)	
p-value	0.6292	

FIGURE 6
Adjusted Quiz Scores 2019

	Images (n = 603)	Text-Only (n = 411)
Mean Score	4.4975	4.4562
Standard Dev	0.7600	0.8260
95% Confidence Interval	(-0.058, 0.140)	
p-value	0.4123	

Based on the statistical analysis of the images and text-only versions, there does not appear to be a statistically significant difference in mean quiz scores. As a result of this lack of evidence, neither null hypotheses A nor B could be rejected. These findings indicate that the use of decorative images in online modules did not have a significant negative nor positive impact on student performance, supporting findings in some previous studies.[43]

Affective Survey

In the fall of 2019, 985 students completed an affective survey that was distributed at the end of the module. 587 students took the survey after completing the images version of the module and 398 students took the survey after completing the text-only version. The survey was optional, as was each survey question.

The distributions of Q1 and Q3 indicate that both the images and text-only students perceived each version to take a similar amount of time and was similarly challenging. Most

students took less than 40 minutes to complete each version of the module and rated the modules as either a little challenging or not challenging. The Q1 and Q3 p-values of 0.1172 and 0.3770, respectively, indicate that the difference in the distribution for each question was not statistically significant (figures 7 & 8). The results of Q3 also mirror the 2019 cumulative and adjusted quiz scores (figures 5 & 6).

FIGURE 7 Q1: How Long Did It Take You to Complete the Module?					
	Images (n = 587)		Text-Only (n = 397)		
Less than 30 minutes	174	29.64%	113	28.46%	
30–39 minutes	162	27.60%	130	32.75%	
40–49 minutes	98	16.70%	75	18.89%	
50–59 minutes	83	14.14%	36	9.07%	
60–69 minutes	46	7.84%	25	6.30%	
70+ minutes	24	4.09%	18	4.53%	
p-value	0.1172				

FIGURE 8 Q3: How Challenging Was It to Complete This Module					
	Images (n = 587)		Text-Only (n = 398)		
Very challenging	32	5.45%	15	3.77%	
Somewhat challenging	162	27.60%	124	31.16%	
A little challenging	230	39.18%	159	39.95%	
Not challenging	163	27.77%	100	25.13%	
p-value	0.3770				

The distributions of Q2 and Q4 indicate that the perception of newness and clarity of information presented in each version was similar for both sets of students. Most students in both versions rated most or some of the information as being new and that the information was presented very or somewhat clearly. The Q2 and Q4 p-values of 0.2471 and 0.5050, respectively, indicate that the difference in the distribution for each question was not statistically significant (figures 9 & 10).

The distribution of Q5 indicates that the perception of images in helping students complete the module was similar in both sets of students. The majority of students in both versions rated images as being either very impactful or somewhat impactful. The Q5 p-value of 0.1672 indicates that the differences in the distribution were not statistically significant (figure 11).

FIGURE 9 Q2: How Much Information Presented in This Module Was New to You?					
	Images (n = 587)		Text-Only (n = 397)		
Most of it was new	160	27.26%	116	29.22%	
Some of it was new	290	49.40%	173	43.58%	
A little of it was new	99	16.87%	83	20.91%	
None of it was new	38	6.47%	25	6.30%	
p-value	0.2471				

FIGURE 10
Q4: How Clear Was the Information Presented?

	Images (n = 586)		Text-Only (n = 398)	
Very clear	226	38.57%	162	40.70%
Somewhat clear	279	47.61%	185	46.48%
Somewhat unclear	64	10.92%	45	11.31%
Very unclear	17	2.90%	6	1.51%
p-value	0.5050			

FIGURE 11
Q5: How Impactful Were Images in Helping You Successfully Complete the Module?

	Images (n = 587)		Text-Only (n = 398)	
Very impactful	87	14.82%	55	13.82%
Somewhat impactful	265	45.14%	185	46.48%
A little impactful	124	21.12%	101	25.38%
Not impactful	111	18.91%	57	14.32%
p-value	0.1672			

The p-values for the differences in the distribution of answers for Q1 through Q5 were all above 0.05, indicating that the distributions were not statistically significantly different from each other (figures 7, 8, 9, 10, and 11). As a result of this lack of evidence, null hypothesis C could not be rejected. However, the inability to reject null hypothesis C provides important insights as to how decorative images influence students' perceptions of online modules.

Discussion

The findings of this study provide librarians with flexibility in deciding whether to use decorative images when designing online modules. The difference in quiz scores over two years between the images and text-only students indicate that images did not have a statistically significant impact on student quiz scores as well as very miniscule differences in actual quiz score differential. The lack of impact from decorative images is especially noticeable due to the fact that the higher scoring groups actually reversed between 2018 and 2019.

Although the quiz score findings support research conducted by Lenzner, Schnotz, and Müller on the lack of either positive or negative impact from decorative images, the authors of this study were surprised that the images did not lead to noticeable differences in cognitive overload.[44] This finding is due to the similar distributions across both module versions in the affective survey, but particularly in the areas of completion time and ease (figures 7 & 8).

The lack of cognitive overload may be a result of the modules containing a low amount of intrinsic and extraneous cognitive load related to the content students needed to learn. From the intrinsic perspective, the content pages were limited to one topic per page, and were presented at an introductory level to reading a scholarly article. The 2019 affective survey indicates that while many students from both versions perceived the information as new, which would raise cognitive load, a majority also rated the challenge of each version as a little or not challenging (figures 9 & 8). This dichotomy suggests that while most of the information in the module was new to the students, the topics themselves were introductory or basic

enough that learning them was relatively easy for college students, which in turn may have reduced the intrinsic load. From the extraneous perspective, the module content pages were intentionally short, and few of the content pages required students to scroll down to read all of the content. The fourth question from the 2019 affective survey also provides evidence that the content was presented in a manner perceived to be very or somewhat clear by over 85 percent of students in both versions, which may have reduced the extraneous load (figure 10).

These intrinsic and extraneous factors related to the introductory nature of the online module fit well within Mayer and Moreno's framework to mitigate cognitive load.[45] It is possible that the content and organization of the modules were designed to lower the cognitive load enough that the addition of decorative images would not cause cognitive overload for students. If so, it may be more important for a librarian to first think holistically about the instructional design of a module and the complexity of the topics being taught to determine if the cognitive load is low enough for decorative images to be included.

The quiz and affective survey results also indicate that the decorative images did not create a noticeable seduction effect on the images group. The images did not appear to distract students' attention, divert their learning from the content, nor disrupt them from creating a coherent mental model in a meaningful way.

One interpretation of why the seduction effect is not evident could be through the lens of user experience studies. Nielson, Norman, and Pernice's research indicates that online users ignore decorative images, especially if they are boring, generic, and look like stock art.[46] The decorative images chosen for the images version were stock images and photos, which could explain why students ignored them. This interpretation suggests that stock images may be best to use as decorative images in order to avoid the seduction effect in online learning.

It is also particularly surprising that there were similar results on Q5 of the affective survey between both groups' views on the impact images had on completing the module (figure 11). The authors expected a greater response of "a little impactful" or "not impactful" from the text-only group due to the fact that those students did not encounter any images. Instead, the text-only group answer distribution mirrored the images group distribution.

The authors hypothesize that the mirroring of the Q5 distribution is evidence of Serra and Dunlosky's multimedia heuristic, namely that both sets of students believe that images with text produce better learning.[47] The present study expands on Serra and Dunlosky's findings by demonstrating that the multimedia heuristic endures without the presence of images and without students being prompted to think about images before completing a module. In Serra and Dunlosky's study, students were asked about their beliefs concerning images and learning at the beginning of the experiment, which could have primed students to believe images were important.[48] The present study only asked students about the impact of images after the module was completed and still found evidence of a multimedia heuristic.

The multimedia heuristic may also explain why librarians often feel a need or pressure to include decorative images in online modules. This may be due to feedback from students who have an assumption that images improve learning in an online environment. It is also possible that librarians themselves have internalized this multimedia heuristic. An interesting follow-up study could examine if the multimedia heuristic is present in librarians. Further research into this area may also be beneficial to the area of usability testing of online tutorials.

Limitations

A number of limitations should be considered in this study. First, the study focused solely on decorative images. Further research is needed to determine the impact of decorative images in conjunction with instructive images, as online modules often use a combination of both.

Second, the context in which the module was completed is relatively rare in academic library instruction because most online modules created by librarians are not required to be completed as part of a credit bearing course. Further research is needed on the impact decorative images have on online modules that are not required but rather voluntary. This study also did not control for the type of screen used, nor did it compare students' perception of completion time to actual completion time.

Third, students in this study did not experience time constraints when completing the modules; however, some online tutorials require students to complete them in a set amount of time. Students under a time constraint could be more impacted by decorative images by adding cognitive load or distracting them from the instructional content. Additional research on the intersection of time constraints and decorative images on cognitive load would be beneficial.

Fourth, this study only examined student performance during the module. While this is an accepted methodology in research regarding the impact of images, the results cannot be used to measure the impact of decorative images on the long-term retention of information.[49]

Fifth, in the affective survey students were limited in their ability to answer Q5 because the option "not applicable" was not provided. The lack of this option may have impacted responses from the text-only group. However, the authors believe that this limitation is minimal due to the included Likert scale option of "not impactful" as an appropriate alternative.

Finally, it must be acknowledged that the definition of decorative images in the literature is problematic. Many definitions use the term "neutral" to describe decorative images, but claiming the neutrality of an image is inherently biased as it is based on the aesthetic preferences of the viewer. An acknowledgement of this issue may explain the blurring between the definitions of decorative and seductive images in the literature; however, this in turn makes it hard to find a standard definition or criteria to apply to either type of image. Further discussion into the definitions of image type and criteria is needed.

Conclusion

As online learning becomes increasingly prevalent in academic library instruction programs, this study should aid librarians in their understanding of online learning when creating asynchronous modules. A general takeaway from this study is that decorative images can be used in modules but should not be considered as a method to increase comprehension of material, nor should they be considered a significant barrier for students. These findings should provide balance to those who enjoy incorporating decorative images to those who find them potentially distracting.

However, the lack of impact from decorative images in this study does not give librarians carte blanche for their use. Librarians should prioritize the application of instructional design best practices to reduce the cognitive load students will experience from an online module and then decide whether to include decorative images. This is especially true if the module contains a variety of media, if students need to learn a new or unfamiliar technology, or if the concepts being taught are difficult to comprehend.[50]

Additionally, librarians need to be aware that while students expect images to aid in their learning, the evidence does not support this belief. Student feedback on online modules should be analyzed with the knowledge that students internalize this multimedia heuristic.

Acknowledgments

Appendix A. Decorative Images
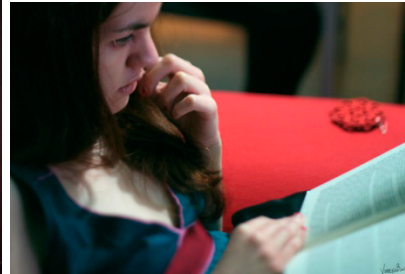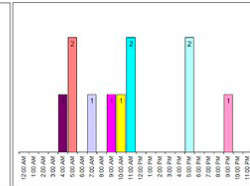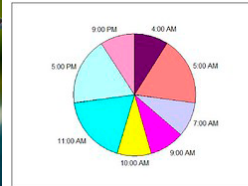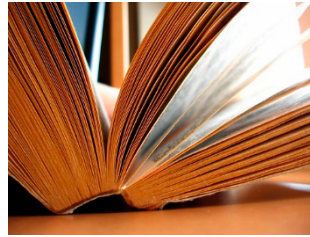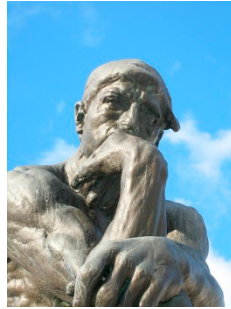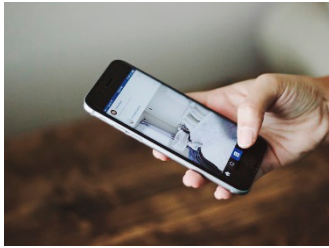
Appendix B. Cumulative Quiz Questions

Question 1: In which section will you most likely find the researcher's interpretation of the results?
- Results
- Introduction
- Discussions & Limitations
- Methodology

Question 2: Why is it important to gather background information before reading a scholarly article? Select up to two answers.
- To introduce yourself to technical words common in the field
- To find and read other scholarly articles written by the author
- To confirm the findings of the article
- Authors of scholarly articles already assume the reader is familiar with the general topic

Question 3: Who is the intended audience of the example scholarly article? (Link to article: "The invisible addiction: Cell-phone activities and addiction among male and female college students," https://doi.org/10.1556/jba.3.2014.015)
- General population
- Scholars in psychology
- Scholars in electrical engineering
- Scholars in computer science

Question 4: Why should you always read the abstract of an article first?
- To make sure the article is relevant to your topic
- To skip reading the introduction
- To find a quick quote for a paper
- To completely understand the article and to skip reading the entire article

Question 5: Based on the conclusion, which of the following are the three main points of the article?
- Addictive activities do not vary across genders
- Certain activities performed on a cell-phone are more likely to lead to dependence
- Time spent on a particular activity does not necessarily signal that the activity is addictive
- Students in college spend around nine hours daily on their phones

Question 6: Why is it important to take special note of words like "important" or "significant" in the results section?
- These phrases are signals from the author about technical language that is important to know
- These phrases are signals from the author of an important result
- Theses phrases are signals from the author about an alternate hypothesis
- These phrases are important keywords from the article

Question 7: When reading the methods section, which suggestion should you keep in mind?
- Circle the words you don't understand and look them up
- Skip words you don't understand
- Read the methods section first to get an overall sense of the article
- Ignore surveys and measurements used as they are only relevant to the current study

Question 8: According to the authors in the "Study Limitations" section, which of the following are two limitations of the study?
- The incorrect cell-phone addiction scale (MRCPAS) was used
- Sample was not chosen on a random basis
- Cell-phone addiction scale (MRCPAS) requires further psychometric evaluation
- Inadequate sample size

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