ANALYSIS ON THE GO:
EFFECTIVE WAYS OF USING MOBILE APPLICATIONS
IN DESIGN EDUCATION

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ABSTRACT

The purpose of this paper is to explore ways to use mobile applications that expand learning within and beyond the formal classroom. The research particularly examines the effective use of a social-networking mobile application as tool in design education. A classroom is usually a confined space which limits an in-situ part of the learning in design. In order to promote versatility and flexibility of learning in various interior contexts, students should have opportunities to explore and analyze key design components in authentic physical interior spaces. This study uses a mobile photo/text/video-sharing application called Instagram as a platform to enable students to easily share visual- and text-analysis of lighting design elements and principles of interior spaces.

Their visual analysis is then shared with an instructor every week through a course-restricted mobile account. The study is divided into three phases to assess the effective use of a mobile tool in this course activity. A visual rubric was developed to aid in the use of mobile learning throughout the phases. This methodology may be applicable in other disciplines to help extend knowledge beyond the formal classroom setting. Integrating mobile application as a learning tool may allow students to think, analyze and apply design ideas outside of a constrained classroom space.

Keywords: mLearning, visual rubric, assessment, social networking, engagement.

INTRODUCTION

The way in which many of us learn, process, code and decode knowledge is changing from a historical physical platform to a digital one. Many people now read their news and other information through the use of their mobile devices. Physical text-based contextual learning is increasingly being modified to include learning in digital visual-based platform (Kovachev, 2011). There are currently a wide variety of digital applications that aid in classroom learning through mobile devices.

Teachers have found using mobile devices and applications can create immersive learning experiences which allow learners to interact with learning information more effectively (Dunleavy & Dede, 2014).
This change is impacting various disciplines, including design education. This new approach has raised some questions about how to bring the aspects of real-world settings into the classroom, so students can obtain more tangible, hands-on learning experience (Lin, 2014). The understanding of design elements and principles can be challenging in a digital platform because the physical environment is not just a representation of a space but it is the culmination of senses, atmosphere and emotions through all design components together (Lin, 2014). The exploration of senses, emotional expressions and symbolic meanings are limited in a confined classroom. In order to bring the physical experience of interior space, it is best if students can have an opportunity to be present in that space, learning, identifying and analyzing essential design components. Creative use of mobile devices can help students engage in-situ, applying learning content from the classroom to real-world setting (Dunleavy & Dede, 2014).

This study is conducted in an Introduction of Lighting Design class. The class is one of the required lecture courses in an interior design curriculum at a small liberal arts private university. Learning technical applications of lighting design is important but the understanding of the application in an interior space is crucial for designers. In order to aid understanding and application of how the components of lighting design are integrated and designed in an interior space, analysis of the components in a physical space is essential. Mobile devices have been utilized as visual- and text-contextual platform for learners to conduct lighting design analysis in various interior spaces. The purpose of this study is to explore ways to integrate mobile learning more effectively in design education.

LITERATURE REVIEW

Use of Mobile Devices in Higher Education
The concept of mobile learning originated as one of many active learning methodologies. One definition of active learning is those activities that promote collaborative learning among students on an assigned task in the classroom (Prince, 2004). With wide accessibility of mobile devices, these were considered as tools to aid active learning in a classroom. Smart phones and/or mobile tablets introduced the flexibility of push, pull, and lift information contents through various software applications and share the contents instantly beyond physical boundary (Diemer, Fernandez & Streepey, 2012). The current research shows that many students have had positive learning experiences using mobile devices as learning tools and the devices have become a potential catalyst for active learning opportunities (Diemer, Fernandez & Streepey, 2012).

As the use of mobile devices is increasing, higher education explores various ways of using the devices as an effective educational tool in teaching and learning. Mobile technology integration requires not only the conventional way of teaching in a classroom but also organizational changes in where and when learning could happen (Cavanaugh, Hargis, Munns & Kamali, 2012).

Initially, the use of mobile devices in education has been treated as technology resources, professional development, and support, which had great emphasis in teaching rather than students' learning (Goksel, & Hargis, 2013; Dawson,
Cavanaugh & Ritzhaupt, 2008). Recently, the focus of mobile technology in education has shifted to promoting meaningful and engaging learning experience for students (Hargis, Cavanaugh, Kamali, & Soto, 2013; Cavanaugh, Hargis, Munns & Kamali, 2012). The research presents positive learning outcomes from the use of mobile learning in class but it demands creative and innovative design of activities that are educational and meaningful and are simple and clear to follow and engage (Kinzie, 2010). It is evident that engagement in active learning improves quality of learning (Harper & Quaye, 2009). Through use of mobile devices, the engagement of learning has changed from physical interaction among students to interaction in digital platform. Mobile devices should be utilized to motivate and engage students in learning and collaboration.

The main advantage of using mobile devices is that students have instant access to information and converse with others which provides great flexibility of time and environment (Hargis, Cavanaugh, Kamali, & Soto, 2014). It allows students to apply their knowledge in similar real-world contexts (Mastre, 2002) and presents great potential to direct higher education in a flexible, student-centered learning (Hargis, Cavanaugh, Kamali, & Soto, 2014).

**Mobile Learning in Design Education**

Digital technology in design education has been widely used in the way of a production tool. Understanding of "in-situ" mostly considers environmental condition of a project because the sun and wind movement of the site do impact spatial quality of interior space. However, built environment design cannot overlook the importance of creating an experience “in-situ,” using various design components. Students need to develop their own design perception that integrates the senses to experience and emotions to create aesthetic and functional environments (Lin, 2014; Dineen & Collins, 2005). Therefore, developing an analytic eye of identifying and articulating design elements and principles in spatial design is essential in design education.

In the 21st century, analysis is one of critical aspects in structured creative design process in design education because design discipline is more than just professional education, requiring critical thinking and analysis of spatial quality. Similar to the disciplines of science and technology, design requires logical and critical thinking and verification and clear rationale behind design decisions (Lin, 2014). In design education, application of the analysis is critical since the knowledge that is presented in class cannot be stayed as a theory but will need to come alive as practice-based learning in real-world settings. In order for students to learn how spatial elements and principles are integrated and applied in various interior spaces, it is the best for them to physically visit these spaces and conduct analysis "in-situ." "In-situ" is important not only being in the space to analyze design components but also it allows learners to be immersed in the space using their knowledge and senses to analyze spatial experience. This kind of “in-situ”-integrated participatory learning help learners to transform their knowledge in relation to the world around them (Driscoll, 2000).

Mobile, context-aware technologies such as tablets and smartphones can allow learners to communicate their observations and interact with digital information within a physical environment (Dunleavy & Dede, 2014). Since mobile learning
activities allow learning to be taken outside of the formal classroom, students can begin to apply their learning anywhere they may travel, which provides them with the freedom of location and time of learning activities. Students enjoy this way of learning because it allows authentic, active learning centered through their devices which can be personal, extensible, and used as a cognitive toolbox (Hargis, Cavanaugh, Kamali, & Soto, 2014). It can become a transformative tool for teaching and learning (Azuma, Bilot, Behringer, Feiner, Julier, & MacIntyre, 2001; Dede, 2009; Johnson, Smith, Willis, Levine, & Haywood, 2011). Students can collect and analyze data instantly through their mobile devices in physical spaces and share the learning with others anywhere in the world. The use of mobile devices in learning enables students to see the world around them in different ways and engage with realistic issues in a context (Klopfer & Sheldon, 2010). Consequently, learners can develop multiple perspectives that cannot be conveyed in a confined classroom; can apply knowledge to analyze design issues in situated learning; can share their analysis in visual- and textual- format anywhere, anytime (Dunleavy & Dede, 2014).

The research shows that the successful integration of mobile learning requires clear and creative instruction that is "rich, loosely structured guidance (such as apprenticeships, coaching, and mentoring) that encourages meaning-making without imposing a fixed set of knowledge and skills" (Lave & Wenger, 1991). Many students primarily use their mobile devices to communicate with others and to access web contents quickly. However, specific guidance for using mobile learning in an educational capacity will need to be developed for successful mobile learning integration into teaching and learning. The design of such guidance has evolved as a visual rubric throughout this study which has helped students to conduct mobile learning in a clear and effective way.

METHODS

Introduction to the Lighting Design course was selected for this study, which occurred in the spring 2016 semester. This is mainly a lecture course, so exploration of lighting design components in interior space was limited. However, this limitation presented an opportunity for mobile learning. In this study, qualitative pattern analysis has been conducted in three phases to explore the effective use of mobile application in design education. The main mobile device used was student’s personal smartphone, and for the lighting design analysis, the mobile application Instagram was chosen by students on the first day of Spring semester 2016.

Students started their mobile learning design analysis on January 18, 2016. The mobile learning assignment was called, "Analysis on the Go." Students were required to post a picture of interior space where lighting design is prominent and text of lighting design analysis in weekly-basis during 16 weeks of the semester. Students’ Instagram posts served as their informed consent as per an Institution Review Board (IRB) requirements.

- Expected learning outcomes of this mobile learning activity were to:
  - Develop analysis skill by critically analyzing lighting design elements and principles in the context of interior design;
  - Connect visual and verbal analysis; and
  - Integrate learning in everyday settings.
Process
A total of 10 students participated in this study. Nine female students (mean age: 24) and one male student (age: 28) participated. The study evolved throughout the semester based on students’ feedback and the discussion between students and the instructor. Students were required to post their analysis as a direct message in @cuhld, class restricted Instagram account.

In the beginning of every week, the class as a group reviewed their posts in class to discuss and improve the quality of visual- and text-analysis together. Based on the discussion and students' feedback, their analysis evolved throughout three phases (01, 02, and 03). The process of the study is illustrated in Figure 1.

Figure 1.
Illustration of the Study

Phase 01: General Overview
In this phase, the mobile learning weekly assignment was presented to students on the first day of spring semester 2016 as Figure 2. Students preferred to use Instagram over other mobile applications because they liked its ability to share photos and texts instantly. A class restricted Instagram account (@cuhld) was created for students’ privacy and class contents. There was no additional instruction provided, except asking students to share photos and provide a short description of capturing the effectiveness of lighting design in various interior spaces. The expected learning outcomes were shared with students in the beginning and several times throughout the session. The first phase lasted from January 18, 2016 to February 21, 2016.
**Phase 02: Model**
After four weeks of the semester, students expressed their thoughts that the instructor’s remarks of weekly discussion of their analysis post were insufficient. Students requested an example that demonstrates identification of key lighting design components and analysis of lighting design in relation to interior space. The instructor found that the text comments to their post and verbal in-class discussion needed to be articulated as an example that clarified instructor’s expectation of design analysis (Figure 3). This phase lasted from February 22, 2016 to March 20, 2016.

**Figure 3.**  
**Example of Mobile Learning Analysis**

As illustrated in Figure 3, students were asked to identify the name and location of a space, where they were to respond to the following six questions:

- What is your overall impression of lighting design in the space?
- What kind of lights are used in the space?
- What are the type of luminaries?
- What is the illuminance level in the space?
- What is the chromaticity and CRI and their relationship to surface materials?
- Are there any other aspects that are related to what you have learned from lighting design class, which you can identify in this space?
An additional email was prepared and sent with instructions, which included more guidance for the procedure:

"You do not have to follow an exact format, but you should practice using technical, psychological, and physiological vocabularies as well as information that you have learned from our class. The point of this activity is to try and apply what you have learned from class in an everyday setting. This will help to develop students' ability to look at space and design elements critically."

Phase 03: Visually Descriptive and Point-system Rubric
The instructor witnessed that the quality of students' analysis improved through this activity, but there was a lack of information hierarchy in their analysis. As they learned more about lighting design, students were able to identify essential components of lighting design in an interior space.

**EID 325: Lighting Design Analysis Rubric**: 20 points total for each analysis

<table>
<thead>
<tr>
<th>POINT</th>
<th>QUALITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>POOR: not addressed</td>
</tr>
<tr>
<td>1</td>
<td>LIMITED: identify just stating the fact e.g. space is spacious.</td>
</tr>
<tr>
<td>2</td>
<td>GOOD: stating the reason e.g. space appears to be spacious because of brightness of lighting</td>
</tr>
<tr>
<td>3</td>
<td>GREAT: articulating the relationship between lighting and interior components e.g. Because of amber peripheral lighting on all walls and brighter ceiling, the space appears to be spacious.</td>
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**Figure 4. Visually Descriptive & Point-system Rubric**
However, students felt that the six questions did not encompass the overall analysis of lighting design. From the discussion with students, a visual rubric was developed (Figure 4) and its exemplary analysis post were presented to students (Figure 5) for clarification of expectations of this activity. This phase lasted from March 21, 2016 to May 8, 2016.
This rubric presented three major categories of lighting design:

- Lighting + Space (L+S)
- Lighting + Color (L+C)
- Lighting + Aesthetics (L+A)

A point system was integrated to identify hierarchy of information and evaluate their analysis in systematic way. These categories were presented in a graphic format that identifies and describes effect of lighting design components in interior space. Students were encouraged to create their own analysis based on the rubric.

RESULTS

A Wordle (www.wordle.net) application was used to identify keywords that students mostly utilized in their analysis post in each phase. One analysis per students was selected to examine the patterns of keywords in their analysis. Figure 6 presents the result of phase 01 of each student.
The word, "light" was identified as the key word in this phase. It was difficult to identify the hierarchy of students' descriptive words in their analysis. Students often used the words "like" or "don't like" in their analysis which does not provide meaningful assessment of spatial analysis. In their photo analysis, light fixtures were often the focus of the photo rather than light and space. These kinds of
photos cannot depict how lighting design impacts the overall design of interior space.

The result of phase 02 shows that students started to examine lighting design in relation to space (Figure 7). There are more rich descriptors to analyze lighting design components. Various action words such as "create" appeared as one of the keywords in their analysis. A couple of students used the word "area" as a
main keyword which describes spatial quality of the space. Students began to describe the impact of lighting design in the ceiling, wall and floor all together in relation to spatial quality. Their perspective photos of interior spaces developed to communicate information of how lighting design components affect emotive aspects of interior space.

Figure 8. Result of phase 03

In phase 03, students demonstrated a good understanding of how lighting design impacts spatial quality of interior space, visually and verbally (Figure 8). All students were capturing major lighting design components (light fixture, window, skylight) and immediate interior surrounding of the space in their photos and
analytic description. From their photos, one can see how materials from the wall, ceiling, floor and furnishings work together with lighting design. Some students have taken their photos with wide/panorama lens which can skew the image of actual space but it allows the viewer to understand the overview of lighting design of the space. The analytic description was much more articulated. Most key words students used were “space” and “lighting” which aligns well with expected outcomes of this mobile learning activity. Students also described lighting design in terms of different types and key components of lighting (daylight, artificial light), color, texture and material in relation to spatial quality.

Figure 9.
Overview of Pattern Study

Figure 9 summarizes the major words that resulted from the students' analysis. Since the visual rubric identifies three major categories of lighting design: 1. Lighting + Space (L+S), 2. Lighting + Color (L+C), 3. Lighting + Aesthetics (L+A), which aligns with expected learning outcomes, students were clear on what to identify and analyze regarding lighting design components in interior space. The point designation with sub categories within major topics also clarified hierarchy of the information that matters to the design analysis.
Throughout three phases, it was evident that visual rubric was a critical tool to clarify the direction and expected outcomes of the activity. The visual rubric was used to provide the necessary cues and sense of hierarchy of information that were needed for successful design analysis. The outcomes of the study show that the instructor cannot assume students know the direction of how to do the analysis. Students may be an expert in using the mobile application but specific intention and guide of using mobile device in learning should be communicated thoroughly. For mobile activity in design education, it is helpful for students to be guided not only by verbal explanation and an example but also through a visually communicated rubric. Since students are required to communicate in a visually concentrated digital platform, rubrics should correspond to the appropriate format for providing clear direction on how to do in-depth analysis using a mobile device.

DISCUSSION

Use of social-networking mobile applications such as Instagram can be an effective analysis instrument that provides students with great flexibility in ways that learning is not constrained in time and place. It also gives them instant accessibility and freedom to share their analysis and receive comments from an instructor. It provides them with an opportunity to examine and analyze concepts and theories that are learned from the course in real-world setting. The use of mobile devices in design education empowers students to communicate their analysis visually and verbally in various interior spaces which expands the classroom constraint on learning and enriches the learning experience in various physical environments.

This study identifies the importance of a rubric for effective implementation of a mobile learning activity which has evolved through three phases from observations of quality of students' weekly analysis and conversation with students. A visually-descriptive rubric provides a hierarchy of information that is necessary to produce expected learning outcomes of design analysis. From this study, the visual rubric seems more effective in concert with the mobile platform because it considers an alternate form of communication between students and teacher compared to the conventional classroom setting. After all, we are using a highly graphic intensive platform where visual content is a dominant factor. It is evident that when information is communicated visually, learners understand the direction of the mobile learning activity clearly.

At the end of the course, one student remarked, "It was quite the experience. I began looking at lighting more wherever I go which was good because I'm taking what I learn in the classroom to the real world."

When I asked students if they believe they learned more through the mobile learning activity than activity in a classroom, one of them stated, "the more you see the actual space you'll figure out more on how to integrate lighting efficiently."

Positive comments from students regarding this activity confirms that creative ways of using mobile devices in design education need to be explored further.
LIMITATIONS and FUTURE STUDIES

Students conducted these analyses as they were learning lighting design. It is natural that the quality of their analysis in phase 01 was not as in-depth as the analysis in phase 03 because of the timing of learning content presented. By the time they were addressing their analysis in phase 03, their use of vocabulary, terms, and understanding of lighting design in an interior space was much improved. Since the visual rubric clarified hierarchy of information, their analysis became much more organized and comprehensive in relating lighting design components in interior design.

The study also found that understanding various aspects of mobile application is essential. For the privacy of students’ information and class content, the author created a class-specific Instagram account which was @cuhld. The original intention of this mobile learning activity was to have students in class to see each other’s analytic posts. Some students did not want to use their personal account to access @cuhld because they did not want others to see their other personal posts.

Although all the students attempted to create a fake account for this activity in the beginning, we found that creates too much confusion from the student perspective. Our class decided to send their analysis as a direct message to @cuhld, so the instructor can view their posts and individually post comments for them. Although the author reviewed some of their analysis posts together in the beginning of every week, it was not the same as everyone has instant access to the analysis feed. Instant peer review and comments might have enriched this learning experience, so further exploration of various features of mobile tools is necessary to create a full experience of instant converse learning using mobile applications.

Finally, in this study, effective visual- and textual analysis was a major focus. Various mobile tools that provide instant application tools should be further explored. Ultimately, the integration of the mobile device could open creative ways to expand learning in real-world settings, outside of a confined classroom. Another possible study will be measuring how mobile learning helps students to retain learning content more than classroom learning.

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