Visual Awareness: Enabling Iterative Thinking Through Photography

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Abstract. This paper presents research results that aid in understanding how photography can become a tool for iterative thinking as a mode of reflection. The research was conducted in three phases. The first consisted of a specific task: after reading assigned materials from different sources, PhD students had to take a photograph as a visual reading-report. In the second phase, all the created images were presented and discussed during class. In the last stage, the students talked about their experience through in-depth interviews. The findings showed that visual awareness linked observation and reflection at the same time, since the students were continually looking for ordinary objects to carry new meanings that were relatable to specific arguments and ideas expressed in the reading materials. Hence, visual awareness is understood in this paper as a mode of visual perception that enables a process of thinking iteratively about a particular topic. The photographic camera was identified as a thinking tool that could be a valuable device to incorporate into educational activities. Finally, in addition to practicing iterative thinking, students expressed feeling engaged and motivated, enjoying this activity, and embracing the challenge.

Keywords: *art education; design education; photography; iterative thinking; visual awareness; visual literacy; visual thinking.*

1   Introduction

As technology evolves, the 21st century has developed a craving for visual images. Hence, the necessary skills to construct visual messages are now highly rated as well as those required to read them [1]. It is now the time of the visual literates: persons capable of producing images and understand their language. Technological innovations have also democratized the use of visuals. Anyone with a smartphone can now take a picture, use some filters with a few clicks, and produce a high-quality visual image. There are applications available for almost anything one wishes to do with an image, like adding text, shapes, removing the background, modifying color and saturation, adding sound, clipping, and expanding, among other editing activities. However, constructing meaning may not be as easy as enhancing brightness using a filter within an app, for it is necessary to activate other skills such as reflecting and

synthesizing. In other words, even though today almost anyone can produce an image, to become visually literate it is necessary to put into practice specific skills iteratively. This study investigated how visual literacy can be developed in design students over more than two years. The main findings suggest that incorporating visual literacy development in classes also impacts the engagement, motivation, reflection, and performance of the students. This paper presents how visual literacy activities impacted a group of PhD students. The task was to read specific literature for a class and generate a visual report: they had to take a photograph with their smartphone to synthesize any aspect of the reading material.

Three publications related to this subject have been published by the author previously, each with a different emphasis and different results [2-4]. In [2] the starting point was a literature review on the definition of visual literacy, assessing its value for the design discipline. From this another research question arose: What would happen if design students had to hand in visual instead of written reports in design theory class, leading to the identification of the first guidelines for visual literacy and engagement in [3]. The findings directed a follow-up research towards identifying the link between critical thinking skills and visual literacy [4]. It became evident that activities designed to promote the latter were, at the same time, aiding in practicing those associated with the former. Students showed signs of information gathering via observation, synthesis and analysis, among others, which are skills related to critical thinking performance.

The task in the present study was not designed to develop visual literacy, but to promote engagement and reflection in PhD students via the visual literacy thinking process identified by the previous researches. The findings point at a new insight: visual awareness as an iterative mode of reflection that enables students to produce their visual reports. After the students had read the assigned materials, they started noticing their surroundings differently, searching for objects and situations that they could relate to arguments from the reading material. Hence, they became more visually aware of their environment, looking for meaning, going back and forth to the reading material and notes iteratively. This process began to shape an opinion and did not stop until they found something that 'clicked', objects that could express an idea. The students took a few hours to construct their visual report, or even 'a whole day', according to one student. Visual awareness means to be conscious of your surroundings but at the same time carry out an ongoing reflection triggered by them.

This research aimed to contribute to the development of educational tools to facilitate the inclusion of visual literacy activities in lessons and classes. The

main findings show that, on the first level, photography is an excellent tool for visual reporting since students have access to it and use it to express themselves almost daily. Because nowadays smartphones have become an everyday personal technology, students feel confident taking pictures and can construct visual reports with anything they have at hand. On the second level, creating a visual that resembles abstract concepts from specific reading materials is a complex task, requiring deep reflection and thus impacting students' engagement and motivation. These insights became visible in the students' verbalizations, since each one of them had to present their visuals to the class. During each session, there was also a moment to discuss their own process of generating the visuals, conducted in the form of in-depth interviews, which they embraced for expressing their feelings and impressions towards the challenges of the task.

2   Photography and Thinking Processes

At the turn of the 20th century, photographic devices became available for mass consumption when Kodak began producing and selling photographic cameras. However, it was not until the mid-20th century that companies producing these devices were able to reduce their costs sufficiently to make them accessible to a more significant portion of the population. Soon, the middle class had their own portable cameras and photography became a 'special-occasion technology'. With the introduction of smartphones and their photographic capabilities, producing visuals became an everyday activity. Today, 5.2 billion people, representing 67.35% of the world population, own a mobile device [5] and the production of visuals is more extensive than ever. Accessibility is a crucial aspect to understanding why photography has raised new interests in different activities, for instance, in the art creation process [6]. Moreover, taking a photograph is a form of reflexive engagement that could disrupt conventional ways of thinking [7]. The camera could become a 'nomadic weapon' since it can reconfigure reality. Transforming reality is a process in which the photographer conveys new meaning to ordinary objects, establishing new relations between him/her and the photographed objects. Thus, as a tool to interact with and interpret the world, the camera could become a device that triggers reflection, which could be valuable for educational activities. The photographic act becomes a reflexive action that provides students/photographers with a way to construct arguments and statements, manifested in visual form. Producing and interpreting visuals has become more essential than ever. This means that visual literacy has become non-exclusive to designers, visual artists and other creative professionals, and is also important for many other professionals, regardless of their field of expertise.

Several scholars have declared that reading and writing skills may not be sufficient to be literate in the 21st Century [8-10] since there are other skills that are necessary to perform at a personal and a professional level. For instance, it has become harder to do everyday activities for a person lacking the knowledge and skills to send an email or a text. It is also necessary to be able to make sense of visual narratives and embrace different cultures. These multi-literacies have become part of the discussion on the fundamental skills to be developed and practiced in schools [11-12]. There are also other skills that could be equally essential to prepare future professionals, such as ecoliteracy [13-14], concerned with understanding different practices and their impact on the environment and improving them. Visual literacy is part of one of the four abilities for the 21st century identified by the North Central Regional Education Laboratory (NCREL). NCREL describes that effective communication, high productivity, inventive thinking, and digital age literacy are essential for education. The latter is composed of eight categories, which include information and visual literacy. Thus, although NCREL identified as fundamental that students of all ages develop the capacity to produce visual messages and interpret them – as the conventional definition of visual literacy states – there are other essential skills as well.

Historically, educational institutions and practices exiled visual images for a long time, leaving written and verbal language in a privileged spot [15]. The ancient Greeks were the first to look with disdain on visual images and perception through the senses [16], because appearances are often deceiving and can even represent illusions. Nevertheless, perception and the senses are the tools that human beings use to understand their surroundings. They can already see and recognize objects and persons at a very young age, long before they begin to speak [17]. Thus, various questions arise: can visual images trigger reflexive actions and modes of thinking? And also, could the process of creating them become a cognitive vehicle to understand the world? What would be the best ways to discover the advantages of incorporating creating visuals as a resource for reflection in education? These questions also inquire whether students can develop a skill set to understand and construct visual images, in other words, to acquire visual literacy skills and the best methods and practices to teach them.

Scientific associations are founded, among other objectives, to discuss and if possible reach consensus regarding certain topics of specific fields of knowledge. This study took the International Visual Literacy Association (IVLA) as locus of consensus on the definition of visual literacy [18]. John Debes, the founder of IVLA, was responsible for coining the term in 1969, defining visual literacy as follows:

"*Visual Literacy refers to a group of vision-competencies a human being can develop by seeing and, at the same time, having and integrating other sensory experiences. The development of these competencies is fundamental to normal human learning. When developed, they enable a visually literate person to discriminate and interpret the visible actions, objects, symbols, natural or man-made, that he encounters in his environment. Through the creative use of these competencies, he is able to communicate with others. Through the appreciative use of these competencies, he is able to comprehend and enjoy the masterworks of visual communication.*" [19]

The 'vision competencies' referred to by Debes in this definition are essential to graphic design, visual art, communication, and other professional practices based on visual messages. For instance, some disciplines rely on visual representations such as schemas of nature or to explain social phenomena; patents, innovation, and technological development often refer to visual images to describe different mechanisms [20]. The scope of visual practices is broad and so is the gap of knowledge, methods, and tools for developing these 'vision competencies'. This research aimed to contribute to closing this gap and proposes the use of photographic devices to construct images. The visual reports generated as part of the study were presented in class by the participants and the discussion of these images became a platform of expanding reflection from the individual to the collective.

3   Participants and Methods: PhD Assignment

The present research was an exploratory study [21] that aimed to construct new knowledge on how the process of creating visuals triggers a mode of iterative thinking that enhances student engagement and deep reflection. The participants were ten currently active students of the PhD program in Science of the Anthropic Environment, a multidisciplinary postgraduate program offered by the Design Sciences Center at the Autonomous University of Aguascalientes in Mexico. As a PhD group of students, they represented a variety of points of view, because they came from different disciplines, including civil engineering, urban planning, architecture, design, and history. The age range was also broad: the youngest student was 27 and the oldest 46 years. Three were women and seven were men. The participants represented the entire population of the third and second year of the program enrolled in the Mixed Methods and Multidisciplinary Research class in May of 2020. Thus, they did not contribute statistical value to the research but a heterogeneous range of work processes, feelings, expressions, attitudes, viewpoints, and opinions. Moreover, this study departed from a qualitative perspective, where the researcher aims to comprehend deeply how reality affects human beings and how they relate to it, profoundly understanding the subjective aspect of their experiences [22-23].

Experience is an essential aspect of this approach; the researcher allows him/herself to be 'touched by reality' and by the object of study, establishing a 'reflexive and self-critical' position. This approach recognizes that interpretative bias is inescapable and that it is better to take it as an aid to framing the results. This enables the researcher to generate less fragmented conclusions and more holistic insights. Participant-observation was the preferred method, as the researcher was also the teacher of the PhD course. According to Taylor, Bodgan and Devault, participant-observation is a method that considers establishing open relationships with informants [24]. Furthermore, "people are more willing to share information with friends than with strangers", meaning that, in this context, the teacher was a familiar face to share the experiences with. In this sense, better results are obtained "if the person seeking information is a friend with whom the informant shares common values and interests" [25]. In a teacher-student relationship, common interests and values are shared via the course activities; this is why, participant-observation [26] in this case was a way to get close to the students to understand their creation process and how iterative thinking and reflection was triggered by the task of producing the visuals.

This research to understand the students' iterative thinking process while they were constructing visual reports took place in three phases (Figure 1):
1. Participants read the assigned literature and generate a visual report.
2. Participants share and discuss the handed in visuals in the group.
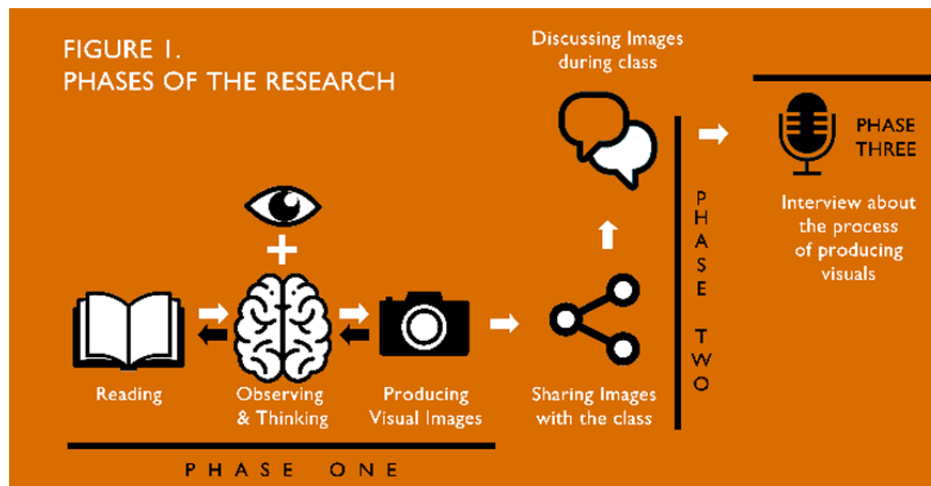3. Participants express and comment on their process during an in-depth interview.

Figure 1 Research phases. Phase one: reading, observing and thinking, photographing. Phase two: sharing, discussing. Phase three: expressing their impressions.

The assigned material included four articles from different sources. After reading them, the students had to produce an image that reflected some of the arguments in the literature. They had to hand in one picture for each reading. It is worth mentioning that this was an online class since the university had implemented confinement measures, by a federation guideline, to reduce the transmission rate of COVID-19 in Mexico. 'Designerly Ways of Knowing' by Nigel Cross [27] was the first text for them to read, assigned so the students could reflect on the difference between design and science, and how they can produce knowledge in design-related disciplines. Secondly, 'La Barbarie del Especialismo' (The barbarity of specialization) by the Spanish philosopher Ortega y Gasset [28] was assigned so the students could reflect upon how specialization in science and other disciplines has produced a fragmentation of knowledge, obstructing multidisciplinary work and research. 'The Design Specialist, Integral Design as a Postgraduate Program' [29] was the third text, so the students could reflect upon the differences between inter-, multi- and transdisciplinary research. 'An Introduction to Mixed Method Research' [30] was the last text, aiming to introduce this type of research to the students and help them incorporate it into their own thesis project.

Figure 1 represents the three phases of the research. In the case discussed in detail in this paper, the first phase consisted of to the assignment to read Ortega y Gasset's article about the dangers of specialization in the sciences. After reading it, the students had to take a photograph to express any arguments or ideas that could be related to the article. Then, every image had to be uploaded to a Moodle-like teaching platform so that everyone could have access to it. The second phase took part during class. Each student presented their visual to the class and how its elements represented concepts from the reading. Every time an image was displayed, the rest of the students could participate and express different opinions about the image or the article.

The teacher also expressed some ideas to enhance the value of the elements in the picture, spike discussion, or build a relation to the literature that could deepen the reflection. Once the assignments were presented, the third phase aimed to understand how the process of producing visuals enhanced the students' reflection process and if they thought iteratively about the ideas in the reading. This information was obtained via in-depth interviews. The participants for the interviews were selected according to Robinson's self-selection criteria, according to which those willing to share their experiences are considered [31]. The interview allowed them to express their feelings and motivation, and the challenges they had to address to construct an image with everyday objects at home since all of them were in confinement. Some of the ideas voiced by the students referred to a keen observation phase, as if they were intensely noticing their surroundings while thinking about the article, which for this research

meant that they had become visually aware. Thus, visual awareness can be understood as an intensive observation phase, triggered by an iterative thinking mode of reflection.

4   Results: Visual Reports

PhD research projects have to be framed, specific and specialized. 'The Barbarity of Specialization' by the philosopher Ortega y Gasset was particularly assigned to the students to challenge their views and provoke them. Among the main ideas, the Spanish author states that it is ridiculous that scientists today know so much about very little. Modern science has produced scholars that are wise only in fragments of the total field of knowledge. For Ortega y Gasset this type of production of knowledge is futile and barbarian. Fragmentary expertise hardens the disciplinary frontiers and puts further apart the fields of knowledge between them, making it almost impossible to establish a dialogue between them and perform conjoint inquiries. He declares that scholars should embrace the word 'university' derived from the Latin *universitas* to refer to a group of people with universal knowledge. This particular article was handed to the PhD students hoping they could open their minds and then consider integrating a multidisciplinary perspective into their research, walking away from a linear, endogamic, one-eyed type of approach. After reading this text, the students had to take a photograph that revealed some of the main ideas expressed by the author. As will become evident from the report below, the visual images did not represent the ideas in the article literally but were a product of the reflections of the students and how they appropriated them into their own discourse. The interviews will show that reflection was possible through iterative thinking and visual engagement with their surroundings.

Below are images handed in by the participants in this study and what they talked about during their presentation. These images were selected to aid in describing that when students finished the reading and looked for objects that resembled the author's ideas, they became more visually aware of their surroundings.

In the first image, the student stumbled upon his son making a puzzle (Figure 2). He then realized that the puzzle could be a metaphor for specialization in science. Afterward, the student asked his son to pose for the picture. When presenting his report, he stated that a narrow view of research activity is like looking at one piece of the puzzle, ignoring that knowledge is intertwined with other areas, fields, and disciplines. The teacher added that focusing on only one piece of the puzzle would make it impossible to perceive the whole image. Moreover, it became evident that sometimes it is necessary to take a few steps back to widen one's perception to understand phenomena.

Figure 2 Visual report by participant A. Specialization is like a puzzle.

Practicing visual awareness was evident in this case. The student began looking for objects to photograph in his home, while at the same time thinking about the article. Going from one object to another, he began trying to see how each one could represent a relatable idea until he found something that clicked. Puzzles are probably one of the most popular games to play at home, with children, during confinement. This everyday object acquired new meaning when he was visually aware of it. Also, he could appropriate the knowledge in the article by associating it with something close to him.

The next picture (Figure 3) shows a magnet on the fridge in a student's home. This object also indicates that, when visually aware, participants could convey new meaning to ordinary objects, resembling a thinking process that relates an object to the article through a freshly conceived idea.

Figure 3 Visual report by participant B. Specialization is like being color-blind.

The souvenir magnet is from the city of La Paz, the capital of the Latin American country Bolivia. The student submitted a double image: on the left side it shows the object as it is and on the right side the object appears in black and white. He stated that a narrow view of scientific research is like being color-blind, unable to perceive the colors of the phenomena. On the other hand, with a broader perception, the researcher can observe different hues, tones, and shades. This student also commented that he could relate these arguments to his thesis project because at first he was reluctant to combine mixed methods and only wanted to focus on quantitative data. However, since his thesis director insisted on including qualitative information, he soon began to, as he declared, 'see color', because he could perceive feelings and experiences from the people involved.

Fridge magnets are a popular souvenir. The student probably looks at this object almost every day or at least every time he opens the refrigerator. However, when he became visually aware and started noticing his surroundings, he could convey new meaning to the objects at hand. The next time he passed the fridge or maybe opened it, a colorful object stood out, and he could reflect upon two things: the article and his own experience. Visual awareness allowed the student to link Ortega y Gasset's arguments to his own research experience. While looking for something to photograph, an idea was shaped through iterative thinking: that specialism is like being color-blind and this idea made him re-interpret his experience and understand it on a different level.

Figure 4 Visual report by participant C. Specialization is like looking at a handful of dirt.

Who would have thought that a pile of dirt in the backyard could be related to the idea of fragmented knowledge in science (Figure 4). For this student, specialized research in science is like taking a handful of soil and focusing solely on what is in your hand. The teacher intervened to support the argument and invited the students to imagine that this picture was taken at the beach. We would have been looking at a handful of sand and might not have been able to see the beach. Also, sand is integrated by smaller particles that can be taken apart for individual observation and study. A single grain of sand does not resemble the beach. The student manifested a particular interest in the reading since she was also trying to integrate different knowledge areas in her thesis project that are commonly seen as separate.

This image is also a great example of how ordinary, even unnoticed objects can become relevant when activating visual awareness. To notice the soil as an object that could express the meaning of fragmentary knowledge, the student had to iteratively think about the article while looking around for something to photograph. She was exploring inside her home without finding anything good enough for the assignment. Then, one of her suppliers sent her a picture of soil to show her a sample, since she was supervising a construction site as a professional architect. Even though that photograph did not come from her own camera, she stated that in a single instant she realized it could represent the idea of portions versus completeness. One of the advantages of visual awareness is that she could have come up with a similar idea while eating a cookie and looking at the crumbles. Visual awareness is a practice that evaluates the capacity of ordinary things to carry new meanings and it is attainable by iteratively thinking of that possibility. In this research, photography was a tool to trigger both.

Sometimes students prefer to bring different objects and configure a scene to resemble an idea in their mind. This does not mean that they are not practicing visual awareness or iterative thinking. Even though they come up with an idea of a scene to build, they still have to iteratively think when looking for the objects that are available. It is closer to a negotiation between the first idea of the composition to photograph and the available objects to do it. Every time different objects are found or become available, the idea has to be updated and thus iterative thinking is still necessary to get the final result. To deliver his visual report (Figure 5), the student used candles, a lamp, a marble, and a micro-magnifier.

Figure 5 Visual report by participant D. Specialized knowledge is like a candle illuminating only a part of darkness.

He stated that candles represented specialized knowledge, which is only able to illuminate part of the field. Then, he declared that this composition was a representation of his thesis work, placing himself at the center aiming to understand an object of study, partialized of course, and bringing knowledge from other authors (the candles) to achieve it. The teacher brought to the class' attention that the candles also produce shadows. In other words, projecting light onto a particular area also casts a shadow over another area. Wanting to produce specialized knowledge on a particular subject could ignore essential aspects of a problem, producing a holographic image of the phenomena. When asked where he got so many candles, the student said that his wife had filmed a music video and they were lying around. Hence, the candles helped shaping his idea for the scene. The magnifier is not a common object. He remembered having it when thinking about the article. The idea for the scene began to take shape while he was looking for objects. Thus, even though he imagined the magnifier, visual awareness allowed him to iteratively think to incorporate other objects at hand and produce his statement.

Instead of identifying an object to project the desired meaning, the next student became aware of a specific space (Figure 6). Once she was aware of how this space could carry meaning, she asked her husband to pose inside that area. With this image, the student illustrated isolation. She said that one of the consequences of specialized research is the isolation of knowledge. Through her

visual report, showing an isolated person, she also wanted to represent physical barriers such as disciplinary frontiers. While looking at the image, the teacher brought to the discussion the concept of 'porous frontier', stating that interdisciplinary dialogue does not necessarily mean bringing down the frontiers, but allowing dialogue, cooperation, and exchanging methods, information and findings. The visual report showed a porous frontier, although this was not the student's intention. You could talk to the person in the photograph, give him or receive something from him, even though he is isolated.

Figure 6 Visual report by participant E. Isolation is a consequence of specialization.

Discussing disciplinary frontiers is an example of how the meaning in a visual report can be extended to spike reflection or introduce related topics to the class. Ordinary things as the ones presented in the reports simplify the ideas in the literature and make the process easier for the appropriation of knowledge. For this student, the spatial divisions in her own home acquired a different meaning by becoming visually aware of them and thinking about it iteratively. This occasion was not the first time she has seen this space and it probably did not have a specific meaning for her; by looking for something to photograph, visual awareness made her look at it differently, producing new and memorable ideas.

The last image in the present paper corresponds to a visual report from a student who declared that he did not agree at all with Ortega y Gasset's arguments. For him, the production of knowledge is only attainable through specialization. One cannot know everything there is to know about a problem; instead, as a

researcher one needs to focus on a framed, partialized object of study. In his report, he gathered several books from different disciplines, to state that his PhD research would not be possible without the specialized knowledge written in those books (Figure 7). His image shows titles referring to structural analysis, philosophy of physics, budget planning, urban planning, and soil mechanics. The teacher brought to his attention that the books displayed belonged to different disciplines and that he was, after all, doing what Ortega y Gasset was demanding scientists should do. Since the PhD program had a multidisciplinary approach, even though he was trying to produce specialized knowledge, he was doing it from a broader perspective. Also, the teacher pointed out that science has still been producing specialized knowledge, even though Ortega y Gasset warned scientists of the dangers of specialization almost 100 years ago. The teacher also directed the group's attention to how universities are working today: faculties are physical barriers that separate fields of knowledge and it has become almost impossible to do conjoint work between them due to administrative barriers. Soon, some of the students provided similar examples from universities they have visited or comments they have heard from outside teachers. As a conclusion, the professor reminded the students that the ideas expressed in the assigned materials had the objective of promoting their reflection upon their research interests and that this course, as Ortega y Gasset's article, should be taken as an invitation to incorporate different views into their project.

Figure 7 Visual report by participant F. Specialized research is necessary.

Without the visual report it could have been harder for the student to state as clearly his disagreement with the author's ideas. The titles of the books displayed in the picture also made his argument easy to understand to the rest of

the students as well for the teacher to expand the discussion. Visual reporting cornered the student to literally show the books with which he had been working, making the article more personal and relatable. Without the visual report it could have been harder for the student to state as clearly his disagreement with the author's ideas. This is probably not the best example of how visual awareness enables iterative thinking since the elements in the image are almost too literal.

5   Results: Student Interviews

The in-depth interviews were carried out to understand the challenges that they faced when addressing the assignment and identify if they were practicing iterative thinking.

The students were asked how they engaged the process of creating the visual reports. Struggle is something that most of them referred to. But most consistently they mentioned thinking a lot of the time about what objects could represent the ideas best that could be related to the article. The following are some of the students' experiences in their own voice.

"[Visual reporting] is a way to reflect and think because you read the text and then you take the whole day to look for something that can represent what you read in the article, maybe a situation or objects that you have at home. I think it was a great way to reflect upon what you have just read; it makes you remember more of it".

"This task was really singular to me. I am an engineer and I tend to be square-minded. At first, when I saw that the task was to take a photograph, to be honest, I took it really lightly. I thought it was something that would not take a lot of my time. I read the article on Wednesday morning, with plenty of time left, and when I tried to take the picture to get rid of that chore, it took me the whole day, I was thinking about what picture to take, what to represent. I thought this task was really ludic and fun. Later on, when I uploaded my photograph on Wednesday night, I realized that I had worked all day to attain that picture. It wasn't stressful, but it kept me working for an entire day. I liked that a lot."

"It was struggling for me. First, to understand the reading, and secondly, to imprint the idea. [...] At first, it seemed like a simple task, but later it took a lot of time, and it became more and more complex. It was an exciting task for me because I have never had to exemplify a concept through a photograph from something I had read. I enjoyed it a lot".

As the last quote expresses, other students also acknowledged an impact on their motivation, even enjoying the task. Expanding the meaning and appropriating the ideas of the article was also spontaneously voiced by some of them, either individually or discussing it with other classmates.

"It was difficult for me because of being confined. I was wondering: What could I possibly photograph in here? In the end, I could find something that made me reflect in a different way that the article intended; it is as if I appropriated the reading. But I liked it a lot, even though it was challenging to find something to produce a photograph within a limited space".

"In fact, I engaged in discussion with one of my classmates because we were wondering which objects could serve better for this purpose."

These are just some of the students' opinions, feelings and experiences expressed by themselves during the interviews. They were selected to be included in this article to highlight different aspects:

- The students acknowledged becoming more visually aware and starting to think iteratively about the reading when trying to convey new meanings to objects through a photograph.
- Producing a visual image to represent an idea that resembles concepts from literature is as challenging as it is engaging, impacting their motivation towards the reading, the assignment and the class.
- The class was extended to their homes, to their children, husbands/wives, to ordinary objects, spaces and situations, facilitating reflection and appropriation of ideas.

Students also stated that each time they had to read another article and produce a new image, creating visual reports became easier and sometimes they even already began to think about the photography while reading the article.

Perceiving that students are engaged is probably one of the most satisfactory achievements that a teacher can have. Knowing what photography could bring as a thinking tool was also rewarding since, in spite of skeptical attitudes towards the task, in the end everyone could construct visuals to provide deep insights into the discussion.

6   Conclusions

Written reports are often mechanic and dull for students. Consequently, they tend to avoid expressing an opinion during class because they are not motivated by the assignment. A photograph can also be a statement. Students imprinted

their ideas in visual images and they showed eagerness to present them in class. The images spiked the class discussion, which first focused on the visuals but soon moved on to focus on arguments about the article and how the main ideas made them look differently at their research. Moreover, the students kept an ongoing reflection, a dialogue with themselves, going over and over to the article to conceive an idea that could be expressed visually. Some of them even established debates with other classmates, exchanging ideas, or discussing how particular objects could express something related to the reading. At the same time, photography, as a means for visual expression, did not represent any difficulties. To the contrary, a smartphone camera is a user-friendly device that everybody has access to and can use without setbacks. Photography is an everyday technology that can be easily incorporated into the classroom. As a visual reporting tool, it could become a means to develop students' visual awareness, enabling iterative thinking, resulting in a deep reflection while also promoting their motivation and engagement.

As an iterative mode of reflection, visual awareness can become a skill to develop. PhD students demand practicing high-order thinking skills in order to perform and attain the necessary insights that a thesis research project demands. To that aim, visual awareness could be incorporated in different activities through postgraduate courses so that students can appropriate it as a thinking skill. Practicing visual literacy could be a path to attaining visual awareness since both are required skills for understanding and producing visuals. The results showed that creating the visual was an activity that provoked the students to become visually aware, hence enabling iterative thinking. But also, interpreting each other's visuals spiked the discussion and expanded the reflection about the article during class. Each new visual that a student presented one-by-one during class was also an iteration of the assigned reading and its ideas, although the teacher guided this part of the activity. Understanding visual awareness and its relation to iterative thinking is still a task that needs further research, as well as identifying the best ways to promote it. Developing tools, methods, rubrics, and other materials to aid in teaching activities are necessary and is a challenge still to be addressed.

Photography as a reflective act is a promising area for educational purposes. The camera as a thinking tool exhibits many possibilities, not only for postgraduate students and not exclusively for design-related disciplines. As seen in this study, producing a visual image was as challenging as writing an essay, even for PhD students. Thus, other disciplines could explore new ways to involve photographic activities to enable different modes of thinking and reflection for educational goals. Photographic devices are everyday technology to which students of all ages have access to. Hence, instead of seeing the smartphone as a disruptive apparatus, it could become a means to promote

reflection, express ideas, and construct a fresh discourse in the classroom. Furthermore, it is fun and engaging, aspects that will impact students' motivation and performance.

References

[1]   North Central Regional Education Laboratory, *EnGauge 21st Century Skills: Literacy in the Digital Age*, METIRI GROUP, http://pict.sdsu.edu/ engauge21st.pdf, (20 January 2015).

[2]   López-León, R., *Primera Aproximación al Concepto de Visual Literacy y su Importancia en la Educación del Arte y Diseño*, Estudios Críticos en Arte y Diseño, in Villagómez, C. & Saldaña, J., Universidad de Guanajuato, pp. 31-48, 2015b. (Text in Spanish)

[3]   López-León, R., *Developing Visual Literacy in Design Students*, Proceedings of the 3rd International Conference for Design Education Researchers, Aalto University, 2015.

[4]   Lopez-Leon, R., & Villa, G., *El Aula de Diseño como Escenario de Exploración entre Alfabetidad Visual y Pensamiento Crítico,* Revista Kepes, **14**(15), pp. 173-194, 2017. (Text in Spanish)

[5]   Turner, A, *How Many Smartphones are in the World,* BankMyCell, https://www.bankmycell.com/blog/how-many-phones-are-in-the-world, (14 June 2020).

[6]   Coats, C., *Thinking through the Photographic Encounter: Engaging with the Camera as Nomadic Weapon*, International Journal of Education & the Arts, **15**(9), pp. 1-22, September 2014.

[7]   Deleuze, G., & Guattari, F., *A Thousand Plateaus: Capitalism and Schizophrenia*, University of Minneapolis Press, 1987.

[8]   Bamford, A., *The Visual Literacy Paper*, Adobe, http://www.adobe.com/ au/solutions/white-papers/education-k12.html, (3 September 2018).

[9]   Riddle, J., *Engaging the Eye Generation, Visual Literacy Strategies in the K-5 Classroom,* Stenhouse Publishers*, 2009.

[10]   Stokes, S., *Visual Literacy in Teaching and Learning: A Literature Perspective,* Electronic Journal for the Integration of Technology in Education, **1**(1), pp.10-19, 2002.

[11]   Kellner, D., *Multiple Literacies, and Critical Pedagogy in A Multicultural Society*, Educational Theory, **48**(1), pp. 103-122, 1998.

[12]   Burn, A., & Durran, J., *Media Literacy in Schools: Practice, Production, and Progression,* Paul Chapman Publishing, 2007.

[13]   Center for Ecoliteracy, *What We Do*, https://www.ecoliteracy.org/about (13 April 2018).

[14]   Lopez-Leon, R. & Encino-Muñoz, A., *Ecoliteracy: Shaping the Design Process from A Systems-based Perspective,* Research & Education in

Design: People & Processes & Products & Philosophy, R. Almendra, & J. Ferreira, Eds., Taylor & Francis, pp. 57-64, 2020.

[15] Kress, G., & Van Leeuwen, T., *Reading Images. The Grammar of Visual Design,* Routledge, 2006.

[16] Arnheim, R., *Visual Thinking,* University of California Press, 1969.

[17] Berger, J., *Ways of Seeing*, Penguin Books, 1972.

[18] IVLA, What is Visual Literacy? IVLA, http://ivla.org/new/what-is-visual-literacy-2, (12 September 2014).

[19] Bleed, R., *Visual Literacy in Higher Education*, EDUCAUSE, https://net.educause.edu/ir/library/pdf/eli4001.pdf, (20 June 2018).

[20] Malhorta, N., & Birks, D., *Marketing Research: An Applied Approach,* Pearson Education Limited, 2000.

[21] Kincheloe, J., & McLaren, P. *Rethinking Critical Theory and Qualitative Research*, The Sage Handbook of Qualitative Research, N. Denzin, & Y. Lincoln (Ed.) , Thousand Oaks, pp. 303- 342, 2005.

[22] Martínez, C., *El Compromiso Interpretativo, un Aspecto Ineludible en la Investigación Cualitativa*, Salud Pública, **33**(1), pp. 58-65, 2015. (Text in Spanish)

[23] De la Cuesta, C., & Otálvaro, C., *La Reflexividad y la Autocrítica como Fundamentos de la Investigación Cualitativa,* Salud Pública, **33**(1), pp. 42-44, 2015. (Text in Spanish)

[24] Taylor, S., R. Bogdan, & Devault, M., *Introduction to Qualitative Research Methods, A Guidebook and Resource,* Wiley, 2016.

[25] Takyi, E., *The Challenge of Involvement and Detachment in Participant Observation*, The Qualitative Report, **20**(6), pp, 864-872, 2015.

[26] Taylor, S, Bogdan, R. & Devault, M., *Introduction to Qualitative Research Methods, A Guidebook and Resource,* Wiley, 2016.

[27] Cross, N., *Designerly Ways of Knowing,* Design Issues, **3**(4), pp. 221-227, 1982.

[28] Ortega y Gasset, J. *La Barbarie del Especialismo,* Los Grandes Ensayos de la Ciencia, Gardner, M., (Eds.), Nueva Imagen, pp. 91-96, 1998.

[29] Lopez-Leon, R. *Los Especialistas del Diseño,* La Transdisciplina en el Arte y el Diseño, C. Villagomez, & J.C., Saldaña, (Eds.), Universidad de Guanajuato, 2016. (Text in Spanish)

[30] Byrne, J. & Humble, A., *An Introduction to Mixed Method Research,* Atlantic Research Centre for Family-Work Issues, Mount Saint Vincent University, 2007, https://www.academia.edu/1476796/An_introduction _to_mixed_methods_research (30 June 2020).

[31] Robinson, O., *Sampling in Interview-Based Qualitative Research: A Theoretical and Practical* Guide, Qualitative Research in Psychology, **11**, pp. 25-41, 2014.