

Board 221: Beyond Surveys: Using Visual Data to Evidence Achievement of Proposed Learning Objectives

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Visual qualitative methodologies enhance the richness of data and makes participants experts on the object of interest [1]. Using visual data brings another dimension to the evaluation process, besides surveys and interviews, as well as depth and breadth to participants reactions to specific program activities [2]. Visual data consists of images, such as photos, drawings, artwork, among others.

The current paper describes the implementation of this methodology for evaluating a site visit to a school building impacted by a swarm of earthquakes that started in December 2019, followed by a 6.4 earthquake on January 7, 2020.

Visits to sites impacted by natural disasters are part of the curriculum of the Resilient Infrastructure and Sustainability Undergraduate Program (RISE-UP). This interdisciplinary program was developed to educate future engineers and environmental design professionals to design and build more resilient and sustainable infrastructure in Puerto Rico. [3]. Currently the island is in the process of reconstruction after Hurricane María in 2018 and a major earthquake in 2020.

RISE-UP developed a novel curriculum sequence that is recognized by the University of Puerto Rico (UPR) as a Minor degree in Integrated Practice in Architecture and Civil Engineering. The curricular sequence consists of four courses and a summer research experience. Course content increases in depth and scope and the last course in the sequence requires students to implement learned concepts and skills in a final design project contextualized to a real-life setting.

Participants in RISE-UP are from three different UPR campuses in different locations in the island, and from three different academic programs. In their courses, students work in multidisciplinary teams that include a ratio of students from each campus and from the different academic programs. Since students' campuses are in different parts of the island, courses are taught online and site visits are integrated into their courses to expose them to real-life settings, have them execute learned skills, analyze, and identify possible solutions for observed problems.

The circumstances for the cohort of students that participated in this assessment activity is different from the other RISE-UP cohorts due to the COVID-19 pandemic. Because of the lockdown, their interaction was solely online. This site visit takes place on their last course of the sequence, so this was the first time that the students were able to meet their fellow classmates after participating in the program for one and a half year.

Instructional activity

All participating students were enrolled in the course *Design-Build Project Delivery (INCI 5036)*. This course is considered the capstone course of the RISE-UP curriculum and requires the

integration of concepts and skills learned throughout previous courses on the design of a resilient and sustainable structure. For this group, the project consisted of designing a module that could be easily constructed or assembled to temporarily substitute a school building or classroom damaged by a natural disaster. The general instructions for this project were the following:

The exercise requires each team to design a modular classroom unit, which when joined with one or more of other similar units will function as a system that operates as a microgrid under the premise of operating in a net-zero manner. As a group, you will select the School or Schools in Southern Puerto Rico that you would be attending with these modules, although the premise is that these units could be used in any school in Puerto Rico that could require it. [4]

Before the site visit, students were lectured on how to rebuild schools, and during the visit their professors and a graduate student explained the structural failures in the design of the building. They studied the original plans and were guided to observe the correspondence between the plans, the structure, and visible damages. After the tour of the school, students were asked to use the site visit experience to discuss their proposed design project and complete an exercise using the technique of *Triple Bottom Line* (TBL)[5]. The instructions for this exercise were the following:

- Imagine that your design project will be in the site-school.
- Identify strengths, limitations, opportunities, and threats for each of the three dimensions of the Triple Bottom Line: Economic, Social, and Environmental.
- Identify three concrete actions to follow in the next phase of your work, one for each of the dimensions of the Triple Balance.
- Be prepared to share the results of your analysis with your colleagues: 1) the three concrete actions, and 2) the results you expect to obtain with each of the actions and how you understand that it will positively impact your design of the module.

Site-visit objectives

For this visit, RISE-UP faculty was pursuing the following four objectives:

1. Expose students to a setting with physical-environmental characteristics like the setting assigned for their final design project.
2. Immerse students, in an experiential way, to the effects of earthquakes on structures, specifically in a school building that was impacted by the 2020 earthquakes.
3. Promote interdisciplinary interaction and collaboration in work-teams through a group activity related to their proposed design project.
4. Encourage team-bonding, through activities that promote social interaction, discussion of ideas, and exchanging experiences.

Assessment method

To assess the impact of the site-visit and determine if the educational objectives proposed were achieved, we used visual data from photos and text from reflexive essays as the evaluation

strategy. Participants were asked to take five photos during the site visit of, either objects, persons, scenery, structures, or any other thing that captured their attention during the visit and write a reflexive essay to answer the following three questions: 1) How do these photos represent your site visit experience? 2) Based on the content of your photos, write about what you learned, discovered, new knowledge acquired, emotions, changes in your way of thinking, etc., and 3) What did you learn or discovered from doing this exercise?

Twenty-two undergraduate engineering and architecture students completed the exercise. The sample consisted of 13 females and 9 males, from the programs of Architecture (36%) and Civil (59%), Electric (36%), and Chemical Engineering (5%).

Results

Essays. For each of the objectives, expected learning outcomes were outlined and a description of what could be considered an indicator of the learning outcome was developed. Based on the defined descriptors, all essays were coded to determine if an objective was represented in the text or not. Two coders read the essays and only those instances where both agreed that the objective was represented, it was coded as evidencing the objective. Learning outcomes and corresponding indicators are described in Table 1.

Table 1. Site visit learning outcomes and corresponding indicators in text.

Learning outcomes	Indicators in text
Students will identify physical-environmental similarities between the site visited and the site assigned for their project.	Phrases related to the relevance of ‘seeing’ how structures were damaged; direct reference to how damages to the structure helped them visualize and ponder their project; statements that reflect possible applications of their observations to the design of the school module.
Students will describe flaws in design and construction observed in a building damaged by earthquakes.	Reference to details of damage in buildings, for example cracks; expressing details and insights about what they learned about earthquakes and construction of structures; design flaws; design conceptualization.
Students will recognize the value of interdisciplinary work and collaboration. Students will recognize the complementary relationship between architecture and engineering.	Describing the importance of their disciplines, and interdisciplinarity; contrasting disciplines and their contribution; phrases about the value of the activity for conceptualizing their projects.
Students will express perceived value from interacting and working with classmates.	Comments related to getting to know each other; reference to a positive dynamic between them; feelings about meeting with classmates, in person, for the first time.

Unintended learning outcomes – students addressed learning or discovering information that was not stated in the objectives for the site-visit.	Stating historical, social, or economic issues; insights and self-assessment of future career plans, highlighting the impact of their disciplines, introspection, and self-assessment of their values. Expressions of admiration for the antiquity of the design plans and that these were drawn by hand.
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Results show that across the total of 22 essays, 32% (n=7) of essays included at least one phrase that was related to the first objective, 59% (n=13) for the second, 73% (n=16) for the third, and 86% (n=19) for the fourth objective.

There were sections in the essays that were considered relevant but were not related to any of the objectives and these were coded as ‘non-intended’ results. Text under this category referred to insights, students’ self-evaluations, future goals, personal values, satisfaction and validation of their career choice, awareness of social, political, and cultural values, among others. Forty-five percent (45%, n=10) of the essays included text under this category.

The following are examples from students’ essays that were coded as representing the objectives and non-intended results (photos are included for those examples that refer to a photo).

Objective 1

"The last detail that I thought was very good is the floor of the court. They appear to be painted vinyl slabs that can be removed and put on like puzzles. This turned on the light bulb for my group on the module project we are doing. It opened our curiosity to find vinyl or other materials that are not so hard and work as a floor, and the fact that they are removable seemed very attractive."



“... everything observed during the tour opened our minds on how to improve some methods for the semester project.”

Objective 2

“Schools affected by the earthquakes were interesting because I was able to see the flaws in short columns that are mentioned in our classes and be able to see the different types of structures in a school, for example, the circular columns and the square columns and be able to hear the explanation of why one is better than the other and how this affects the structure. In addition to this, being able to see the plans of the structure, its legend and how they were made lets me know how the codes and designs have changed and what specific things are taken into consideration when making the design. Being able not only to see the plans of the structure but the electric ones on paper was very curious and impressive, how they were made.”

Objective 3

“What I found most shocking was the collaboration between disciplines. The architecture students had their multi-colored markers and the civil engineering had transporters and rules. Their thinking about conceptualizing ideas also differed. The ones from architecture

immediately began to divide the paper into shapes and circles, while my thought would have been to create lists.”

Objective 4

“Honestly, the opportunity of sitting down to talk and work in person was super rewarding. To be able to read expressions, and share the space with the work team, get to know each other and share stories of the cultures of our campuses and departments, talk about what changes we think our curricula could have... All this helps a lot in generating perspective and improving communication skills and sense of responsibility for teamwork.”

“Being able to do a first meeting in person, really gave more sense of reality to the program, and to the things that we have studied and to the values and the reasons why we are deciding to pursue this curricular sequence.”

Non-intended Results

“History, 1959. This should make us more aware of what kind of footprint we really want to leave for future generations to see. Where is the greatness of the human being? Will we continue to show it through samples of grandeur on nature? Either we will begin to move on, or perhaps rather, 'return' to recognize that humanity's 'progress' falls into how we approach nature, which has had millennia of years improving and evolving exhibiting the base of the concept of resilience and sustainability and not a pattern of infinite growth.”



“The people and the island of Puerto Rico, for the last decade, has experienced the reality of being punched over, and over, again. Hurricane [Maria], punched. Earthquake, punched. Pandemic, punched. Corruption, punched since the colony was founded. For sure, if you keep looking back, perhaps you can deduce that there was never a time when the people did not receive a punch.”

“In the first photo, which I described as "First visit," I had no idea of what I was going to find. Even observing the entrance [to the school] I thought that the school had not been affected until I went in. Then, in the second photo described as "enclosed", it felt hot, there was little ventilation, I felt despair from seeing a court in that location [it was enclosed between buildings] that should be an open area. I started thinking about the children who study there, how much they must sweat, feel locked up as if they were in a prison. The kind of place where you study, I think, affects your school performance. In my case I have studied in schools with big patios, a lot of ventilation and a place to run. Interacting with nature from a young age is very important in our childhood because we learn to love and protect it.”



“In the last photo, described as "Future" [photo is not included to protect the identity of those present] is to see a new generation interested in sustainability and resilience to make a better

world. To be aware that there is still hope for Puerto Rico as for the world. This photo gives us the faith to continue learning, experimenting, and taking courses that teach us to design and create a better world for our children, grandchildren, and future generations.”

“I was able to learn from the process of being critiqued during the design process.”

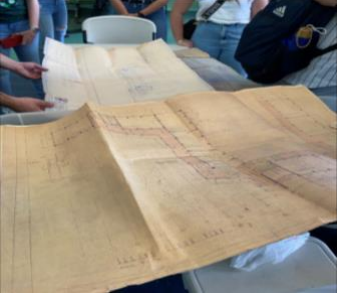
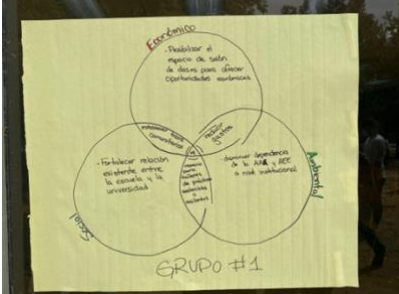

“Something that caught my attention was the school plans. When they opened the box where they had them stored and I saw the amount of papers that were there, it impressed me, because today with the technology we have, we do not need so much and thanks to technology the plans are not made by hand as those engineers who were in charge of the project had to do when the school was built in the 50s and we know that technology at that time was not as advanced as it is today.”

“Thanks to this activity I was able to discover where I want to focus on my Master’s; before, I had doubts about what I would do with my future.”

Photos. In total, there were 113 photos and the number of photos per essay ranged from 5 – 7. Photos were grouped according to its content and three broad categories emerged. The first category consisted of 65 (58%) photos related to the design and construction of the structure and specific damage observed from earthquakes. The second category included 26 (23%) photos of classmates, professors, and group activities, and the last category, coded as ‘other’ included 22 (19%) photos that did not share a common theme. Within these three broad categories, groups of photos that shared a theme were grouped into subcategories. Table 2 includes a sample of photos for categories and subcategories.

There is correspondence between the first two categories and the objectives proposed for the visit. The themes in the photos included in the first category are related to objectives 1 and 2, and the themes in the second category correspond to objectives 3 and 4. If we add the number of photos in these two categories, we obtain that 81% (91/113) of the photos were related with the objectives, of which, 71% (65/91) correspond to objectives 1 and 2, and 29% (26/91) with objectives 3 and 4.

Table 2. Examples of photos grouped into broad categories.

Design & construction of the school; specific damage from earthquakes (n=65)	Classmates, professors, and group exercise (n=26)	Other (n=22)
<p style="text-align: center;">Design plans, n=23</p> 	<p style="text-align: center;">Group exercise, n=17</p> 	<p style="text-align: center;">Details of building, n=8</p> 

Cracks on walls, n=17



Trip to the site, n=4



Columns, n=14



Group of students, n=9



RISE logo keychain, n=2



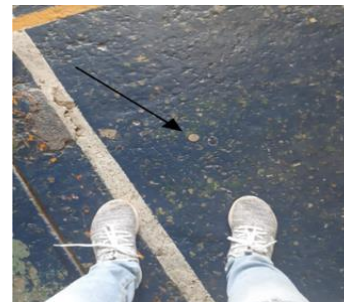
School patio, n=2



School exterior, n=11



Other, n=6



Conclusion

One of the highlights of using visual data in research, for assessment, or other inquiry purposes is that the participant is an active, spontaneous, producer of the data. Through a visual representation of an object of interest, the person captures what he/she considers relevant or valuable. In this assessment activity, participants were asked to take photos during a site-visit to a school damaged by earthquakes. Through this unobtrusive and indirect activity, the evaluator gathered information on what students considered as highlights of the activity; what was considered most relevant, valued, and interesting. Using the photos as prompts to write an essay enabled the communication of perspectives, insights, emotions, and explicit and implicit knowledge that otherwise would probably not be captured through questionnaires. It also provided a novel assessment technique to participants who are used to answering surveys.

In conclusion, both photos and essays demonstrate that the objectives were successfully achieved and encourage the use of visual methodologies as an alternative for the evaluation of educational activities.

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