



A picture elicits a thousand meanings: Photo elicitation as a method for investigating cross-disciplinary identity development

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Abstract—Photo elicitation is a qualitative research method that has been broadly used in the social and health sciences, particularly in the areas of education, anthropology, sociology, and psychology. Although it is a method well-suited to engineering education research questions, there are few examples of why and how to use it in the engineering education literature. This paper aims to demonstrate the unique benefits of photo elicitation as a research method for engineering education researchers, particularly those interested in identity development and in the process of becoming an engineer. We present a review of the utility of the method based in the existing literature, and illustrate its use while verifying arguments for its usefulness through examples drawn from a longitudinal study of cross-disciplinary learning and identity development. We conclude the paper with a summary of the strengths of photo elicitation as a method, lessons learned, and recommendations for using this method more broadly in engineering education research such as studies of conceptual understanding of STEM concepts, teaching and learning, learning systems, and the nature of effective engineering learning environments.

Keywords - qualitative research, photo elicitation, becoming a professional

1.0 Introduction

Numerous studies have examined identity in regards to engineering and engineering education. These studies focus particularly on areas such as gender¹⁻³; recruitment, retention, and burnout⁴⁻⁶; and identity development in becoming an engineer.⁷⁻¹⁰ Various methods have been employed to study identity in these contexts, including surveys, “draw an engineer” tests, ethnography, and personal narratives. While each of these methodologies is important and supplies its own contribution to the discussion of identity, they may not provide an in-depth, interpersonally developed understanding of the participant’s own subconscious and conscious perceptions of his or her reality (or thick description—e.g., Geertz¹¹). In other words, these methods can supply a good articulation of the participant’s conscious reality (e.g., personal narratives and portfolios); they might supply useful quantitative data (e.g., surveys); or they might offer thick description from the researcher’s interpretation of the participants’ actions (e.g., ethnography). But these methods do not access the tacit knowledge and perceptions a participant may hold. To fill this gap, we propose using photo elicitation interviews, a qualitative research method that has been under-utilized in engineering education, although some examples exist.¹²⁻¹⁶

This paper aims to demonstrate the unique benefits of photo elicitation as a research method for engineering education researchers, particularly those interested in identity development and the process of becoming an engineer. We begin by reviewing the literature on photo elicitation, drawing from many disciplinary communities such as anthropology, sociology, organizational learning, education, psychology, and health sciences – effectively creating a bridge between and among disciplinary communities. We then present an example to illustrate the use of this method in engineering education research and to verify existing arguments on its

unique benefits as a research tool. The example used is a study in which engineers at various levels (undergraduates to working professionals) were interviewed twice using photo elicitation techniques as part of a larger series of interviews for a longitudinal study on cross-disciplinary learning trajectories. The overall aim of these interviews was to collect, synthesize, and analyze participants' understanding of their experiences working as engineers in cross-disciplinary situations, as well as their own predisposition toward engaging in cross-disciplinarity. The overarching framework for the study is based on results from a phenomenographical study on becoming a cross-disciplinary professional.⁷ We conclude the paper with a summary of the strengths of photo elicitation as a method, lessons learned, and recommendations for using this method more broadly in engineering education research.

2.0 Literature Review

Photo elicitation is a technique that has been used extensively in the social sciences.¹⁷⁻¹⁹ As a method, photo elicitation was initially proposed by a multi-disciplinary team examining mental health in changing communities in Canada as a way to establish rapport with the interviewee.²⁰ This method is also referred to as photo interviewing²¹, photovoice²², and photofeedback.²³ Photo elicitation as a technique allows researchers to insert a photograph into a research interview²⁴, whether the researchers supply those photos or participants are asked to bring their own. In either case, the participants are supplied “guiding questions” which help them talk about the photo and/or select their photo.^{12, 24}

Arguments for using photo elicitation methods

A central underlying argument for using photo elicitation is that the form used for representing ideas can influence what people are able to say about an idea. Images, having affordances distinct from text or text-based language, enable people to talk about different kinds of things in different ways.²⁵ For example, photos are a way to access participants' tacit knowledge or what they might be hesitant to share. Further, photos help participants explain their experiences in terms of metaphors; individuals who “know it when they see it” can use an image to explain their thoughts, feelings, and experiences. Lived experience can be difficult to articulate because it can be an unconscious process. Photos help to draw these ideas out into the open and get beyond the limitations of the spoken or written word.²⁰ The portions of our brains that process images are evolutionarily older, which means that using images is a way to access the deeper recesses of our subconscious.²⁴

The photos used by participants are not necessarily the focus of the interview; rather, they are used as a departure point to understand participants' perceptions.^{13, 16} As Carlsson notes, photos make it easy to represent a situation and how it relates to a phenomenon – they are not just “of” something but also “about” something.²⁵ They are charged with complex choices about what a person wants to communicate and they carry psychological and emotional nuances and values.²⁵ When participants are asked to bring their own photos, photo elicitation as a method decreases the difference in power between the researcher and the study participants as the participants are in charge of bringing, and in some cases taking, their own photos.²⁶⁻²⁷ In this way, photos have the potential to liberate thinking.²⁵ The photo creates a point of commonality between the participant and the researcher, something that will allow communication to flow more easily between the two parties.²⁸

Approaches for using photo elicitation methods

Photo elicitation has been used methodologically in a variety of ways and has been readily adopted by researchers interested in vulnerable or underserved populations such as inner-city children, cancer patients, and individuals struggling with gender and immigration issues. The original study that proposed photo elicitation supplied the photographs to participants, asking them to use the photos as a starting point for their responses and reflections.²⁰ Other studies have followed suit, particularly when examining gender issues.²⁹ The benefits of this form of the method include not relying on participants to follow through on the requirement to bring their own photos which adhere to assigned categories; having control over being able to generalize the study's results; and ensuring a baseline for comparison. However, this version of the method limits two of the main benefits of photo elicitation in general: empowerment¹⁷ and interviewees' self-reflexivity.³⁰

Another version of photo elicitation asks participants to produce their own images.¹⁷ It has been suggested that it is easier to gain access to typically impermeable research sites using cameras or photographs.³¹ In her study of inner-city children, Clark-Ibáñez supplied the children with cameras and asked them to document whatever they wished for a specified period of time.²⁸ The children's photos were then developed and used as departure points throughout the interviews. This version of the method is one of the more in-depth versions; participants are allowed to supply the photos completely from their own perspective, and are empowered to bring their own voice to the interview. This method allows youth and other potentially disenfranchised individuals to develop their own personal and social identities.³² However, Clark-Ibáñez identified some of the main problems of this form of interviewing: participants might not want to take the photos, they might lose the camera, participants may regret the photos they have taken or they may take different photos than they would if they knew the researcher would not see them.²⁸

The final way in which photo elicitation has been used is asking participants to bring their own photos, though they are not required to have taken the photos themselves. For instance, participants can use old family photos, use a search engine to find photos, or bring in a publication that shows a copy of the photo.¹² This allows participants the chance to use their own voice in supplying the photographs; the researcher is not choosing the photos for the participants, and therefore is not imposing his or her own voice as the base for the participant's. This method also does not ask participants to take their own photos, thereby surpassing some of the complications mentioned earlier; participants cannot lose a camera, and they can change the photos they have chosen as many times as they wish prior to the interview.

Opportunities and challenges with photo elicitation methods

A main challenge of interviewing as a method is participants being hesitant to discuss abstract concepts.³³ Photographs allow participants to feel more comfortable, which helps enable them to speak to more personal or intimate topics.¹⁸ The photo can serve as an anchor point or as a springboard, and represents a sort of safety net for the participant as well as the researcher. Participants can sometimes have difficulty verbalizing their experiences in an articulate manner.³⁴ Photo elicitation allows an entry point for these participants; the burden is not on the participant to come up with a response completely on their own, as they can use the photo to help

them craft their answers. Photos can help jog participants' memories, which can especially help with tacit knowledge.³⁵ There might also be certain topics which participants are aware of, but they are unaware that this is the information the researcher is looking for; photo elicitation can help here as well, as the photos help participants explain their point of view to the researcher.²⁸ Multiple meanings can be represented within one photograph, which allows participants to further make connections across their experiences and understanding of those experiences.³⁶⁻³⁷ Also, when using interviews use photo images, because another apparatus creates these photos they are not as dependent on one's skills in representing ideas as compared to interview methods that ask participants to draw or sketch an idea.²⁵

Researchers need to be especially cognizant of the analysis going on in photo elicitation interviews. Analysis occurs during the actual interview as participants and researchers engage in discussion of the photos.³⁸ What might seem clear to the researcher (e.g., a photo of a boy standing on a sidewalk) can be much more nuanced for the participant (e.g., the boy is their best friend who moved away, with the photo representing the participant's loneliness).²⁸ This process demands not only the participant, but the researcher as well, to engage in self-reflexivity.³⁸ Researchers must show unconditional respect for the participant and their voice, and realize their own positionality in the interviewing process.²⁴

There are, as with any method, potential complications of using photo elicitation. Not everyone has the patience to engage in photo elicitation; the method requires a fair amount of work on the part of the researcher and/or the participant, depending on who provides the photos.²⁸ Developing an interview protocol in and of itself is difficult work, and photo elicitation adds another complex layer to this process. There is also the possibility of privacy invasion, particularly when doing interviews on sensitive topics such as prostate cancer and other major health concerns.^{17-18, 39}

Applications of photo elicitation methods

Since the time when photo elicitation was first suggested by Collier²⁰, there have been numerous departures and variations on the method. Many of these studies are situated in social science and a number of them deal with topics such as health and other sensitive or complex situations. The use of the method with such complex concepts makes photo elicitation ideal for discussing engineering and cross-disciplinary identity development for a few critical reasons. First, engineering, identity, and cross-disciplinarity are all complex, multi-faceted, and relatively abstract phenomena that are unlikely to be explained by any single perspective but rather are best served by bringing in multiple perspectives. Engineering specifically is very complex: it deals with complex problems and is not bound by one definition, but multiple definitions. As such, photo elicitation helps individuals explain the multiple facets of their identity and learning trajectories and, for this study, interconnections among personal, professional, disciplinary and cross-disciplinary perspectives. Second, transitional periods in identity development and becoming an cross-disciplinary engineer are likely to be quite complicated, although there may be a limited number of qualitatively different variations.⁷ Finally, our research is showing that people, regardless of their experience level, do not often engage in deep discussions with others regarding such questions as "what is cross-disciplinary to you?" and "how do you see yourself as cross-disciplinary?" In other words, the interviews we describe in this paper were for many of our participants the first in-depth conversation they have had around these concepts, particularly

from their own point of view.

Photo elicitation has been used extensively with women, children, and minority groups.^{17, 22, 26, 40} It has also been used with cancer patients and those confined to a hospital environment (e.g., Oliffe & Bottorff, 2007 #17; Radley & Taylor, 2003 #18). The method has provided a point of entrance for studying homeless individuals¹⁹, the status of education in Zambia and Tanzania⁴¹, and dietary patterns among minority groups.⁴² Photo elicitation was even used in agricultural practices as a means to allow farmers in degraded lands to show what they needed as means of reasonable land management and to give a platform for them to communicate how they work and affect the land to meet their needs.⁴³

There is a general call for increasing the use of qualitative work in engineering education.^{44, 45} Motivated by the low frequency of use of qualitative research in engineering education and the need for more informed decision-making regarding engineering education research methodologies, Case and Light (2012) summarized different qualitative research methods (e.g., case studies, grounded theory, action research, phenomenography, etc.) and their associated methodological assumptions.⁴⁶ Photo elicitation can provide the sort of qualitative data for which these studies encourage; there are important areas of inquiry that would benefit greatly from the thick description qualitative methodology can provide (e.g., Geertz, 1973).¹¹ For instance, students' perceptions of engineering specialties have been studied quantitatively⁴⁷ but would benefit from a deeper exploration using photo elicitation (e.g., asking students to bring in photos of what they see as representing the different disciplines, or their preferred discipline). Additionally, photo elicitation could help access issues of identity among engineering students and engineers, something that might be more tacit knowledge among participants.^{1-2, 48}

Identity is a difficult concept to research. Self identity is intrinsic in an individual; it is not something that is frequently articulated explicitly. Sometimes individuals—and more specifically, engineers—can have multiple identities, negotiating different facets of themselves.^{2-3, 10} Engineers and engineering students might see that they do not fit within the engineering culture, thus establishing their out-group identity; this is more usually the case with women and those who do not meet the criteria for “academic excellence.”⁴⁹ Self identity can be impacted by perceptions of the organization and the organizational structure.⁵⁰⁻⁵² The varied influences on identity can make it difficult to articulate and parse individual identity, indicating that photo elicitation would be a helpful method to access this phenomenon.

In the following section we present an example of using photo elicitation to illustrate how and why we used this method as well as its unique benefits. The example is drawn from a longitudinal study of thirty engineers with varying experience levels. The study seeks to characterize cross-disciplinary learning trajectories through a lens of knowing (thinking and acting) and being (identity) (Adams 2011 #7). Photo elicitation was used as a method for collecting, analyzing, and synthesizing participants' tacit understandings of the complex phenomena of “becoming a cross-disciplinary engineer.” The study involves multiple methods over a three-year period and includes critical incident interviews and quantitative surveys, though these will not be discussed in this paper.

3.0 Illustrating and verifying photo elicitation methods

3.1 *Illustrating the method – an example study*

As mentioned previously, the two photo elicitation interviews were part of a larger study on cross-disciplinarity involving thirty engineers (or engineers-in-training). The focus of the overall study is to understand participants' experiences with cross-disciplinary work and their evolving understanding of cross-disciplinarity, including how this relates to their understanding of engineering, their "home" discipline, and their sense of self within and across these spaces. The data was collected over a period of three years. The researchers recruited participants by visiting undergraduate engineering classes and sending emails to professional engineers, graduate students, and faculty. Those who responded to the recruitment call were asked to complete an on-line screening survey that included questions about their background and prior experiences. Results from the screening survey were used to strategically recruit participants that represented different experience levels (from undergraduates to working professionals) and epistemological distances (extent to which they worked with people from disciplines that were epistemologically distinct from their home discipline), as well as gender and racial diversity. Those who agreed to participate were assigned a pseudonym to protect their privacy and were compensated for their time with \$50.00 every six months.

The sequence of data collection activities was as follows: a critical incident interview (e.g., critical reflection questions about cross-disciplinary experiences and what meanings they held), a photo elicitation interview (e.g., identity and conceptions related to four photos), an online survey (e.g., cognitive and strategic flexibility, learning orientations, conversational sensitivity, interdisciplinary competency, and frequency of engagement in interdisciplinary activities), a second critical incident interview, a second photo elicitation interview, a second online survey, and an exit interview which included a final critical incident interview, a transformative learning interview, and a personal journey interview. Over the course of the study, all data was de-identified including participants' references to other people and organizations.

Prior to each photo elicitation interview, an e-mail was sent to each participant with instructions for selecting four images and e-mailing them to the research team. As shown in Figure 1, participants were asked to select images that represented, respectively, their personal, professional, disciplinary, and cross-disciplinary identities. These photos then served as the elicitation artifact for the interview. As noted previously, the photo elicitation interview was conducted twice approximately one year apart. For the second version, participants were provided with the same instructions although they were told that they could bring the same photos as the first time, if they wished.

For this next interview, our focus is on learning more about “who you are” and the experiences that have shaped the way you think, act, and see yourself in the world and in relation to others. To do this effectively we will use pictures, that you own or collect from another source, that represent something important to you. These pictures may be in any form – self-portraits, graphic images, computer generated images, pictures of friends, family, homes, co-workers, projects, favorite places, etc. There are no right or wrong pictures.

The pictures we will ask you to provide for this next interview will be held confidential and viewed only by the researchers of this study. The pictures will be used solely for the purpose of our next interview to elicit responses to questions that we have and navigate through the interview.

For this next interview

1. Please find 4 pictures (although you may use as many as 6):
 - a. One that represents something about you as a person
 - b. One that represents something about you as a professional
 - c. One that represents your (primary) discipline
 - d. One that represents your cross-disciplinary work
2. Make sure the pictures are in JPEG format.
3. Email your pictures to – [project email] no later than [date]. In the subject line include your name (Last name, First name) and date (mm/dd/yy). (Note: the photos will be on a password protected system)

Figure 1. Instructions provided to participants for the photo elicitation interview.

When using photos to elicit peoples’ experiences and understandings it is not enough to ask them to describe their pictures; rather, the relevant questions should focus on explaining what the photo represents and means.²⁵ Implicit in every photo are several personal decisions about the places, objectives, and motives within the photo that provide opportunities to express personal conceptions of, and relations to, the surrounding world. Therefore, the protocol for this study began with simple questions about the source of the photos, how participants searched for and selected each photo. Responses to these questions often verified how the photos held deep meanings and were not randomly selected with little thought. For each photo participants were asked, “what does this photo represent (about you, your discipline, your profession, cross-disciplinarity)?” with follow-up probes to elicit the meanings and histories of specific ideas, why these ideas were important, and how these ideas were embodied in everyday activities or conceptions of practice. Because we were interested in how various facets of participants’ identities might be interconnected, the protocol included questions about how ideas depicted in one photo referenced ideas depicted in other photos. Similarly, because developing a cross-disciplinary identity has its own unique challenges we asked questions about community or group affiliations and how participants’ felt perceived or respected by others within and outside their home discipline. At the end of the interview, participants were asked to critically reflect on “what cross-disciplinary practice means for them” and how and why these views may have changed over time. This was common to all the interview protocols in the study.

Below is an example of the kinds of photos participants selected and brought to the interview. Below each photo is the category it represents for the participant (personal,

professional, disciplinary, cross-disciplinary). These are the four photos Evelyn brought to her first photo elicitation interview. It is interesting to note that Evelyn works in a high-profile security position and so she did not include any personal photos in the first interview, although she did include a personal photo in her second interview.



Figure 2. Evelyn's set of four photos for her first photo elicitation interview.

Table 1 provides descriptive information about the participants used in this paper to illustrate and verify the use of photo elicitation methods for studying complex and abstract phenomena such as cross-disciplinary learning and identity development. As shown here, each participant has been assigned a pseudonym. The "status" indicates where they were developmentally (e.g., graduate student, faculty, etc.) at the conclusion of the study. Finally, the "epistemological distance" indicates the breadth of disciplines that the participant interacted with and represents the extent to which the participant interacted with people trained in epistemologically different fields of knowledge. All of the home disciplines for the participants are in engineering. The other disciplines include science (i.e., Engineering x Science), management and business (i.e., Engineering x Management), and humanities (i.e., Engineering x Humanities); there are also instances in which a participant worked cross-disciplinarily with other kinds of engineers (i.e., Engineering x Engineering). Our rationale for including these cases is that this subset of the dataset illustrates the kinds of variations observed in the study - differences in experience level, kinds of cross-disciplinary experiences, and learning and identity trajectories.

Table 1. Characteristics of example participants

Pseudonym	Status	Epistemological Distance
Alice	Graduate	Engineering x Science
Alvin	Faculty	Engineering x Science
Becky	Graduate	Engineering x Science
Bernadette	Undergraduate	Engineering x Engineering
Evelyn	Professional	Engineering x Management
Kyra	Faculty	Engineering x Humanities
Xavier	Graduate	Engineering x Engineering

3.2 Verifying the method

Photo elicitation is a method that allows participants' voices to come through, rather than focusing on the researcher's interpretation of the participants' ideas and experiences. Below, we detail some ways in which photo elicitation allows the participant to assert agency in the research process and help reduce the distance between the researcher and participants.

Individuals will not interpret each experience in an identical manner; interpretations are unique to each individual. Most individuals can fairly easily explain what actually happened in an experience—e.g., they worked on a team with other engineers in order to come up with a new product. Photo elicitation helps us get past these surface descriptions and access what it is that the participants *understand* from the experience, their interpretations of what happened, and self-reflexivity of their own place in the situation. For instance, as Bernadette is asked to explain the photo she supplied for the “personal” category, one of her and her boyfriend, she begins discussing how her interpersonal hardships have affected who she has become. She explains that certain relationships have taught her who she wants to be and who she does not want to be, and she has deliberately made choices which push her in the direction she desires. The photo was an entry point for Bernadette to tap into her perhaps tacit interpretations of her interpersonal experiences. Photo elicitation allowed her to reflect on these interpersonal relationships and, with some further probing questions, gave Bernadette the opportunity to discuss how she reacted to the hardships she faced.

Photos as metaphors

Photo elicitation helps participants articulate abstract concepts, such as identity; in other words, it makes it easy to represent the situation.²⁵ Concepts of “who I am,” “who they are,” and what “that kind of person is” are all abstract in nature and can be difficult to articulate. While the interview protocol asked participants to explain what they thought engineering and their discipline were, the addition of photographs led to deep and nuanced explanations of these understandings. The depth of these understandings was apparent in the participants' use of metaphorical reasoning, wherein photos are used as metaphors or symbols for meanings and understandings that are personal to the participant. Participants used images as metaphors for their identities, their goals, and their values.

As an example of how photo elicitation helps participants explain their perception of their identity via metaphor, Kyra brought in the following picture for her first photo elicitation interview:

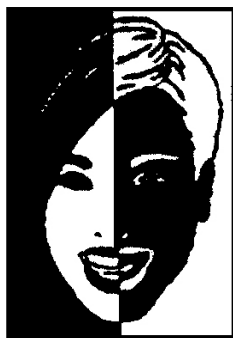


Figure 3. Kyra's "personal" photo for her first photo elicitation interview.

After Kyra explained that this was her photo for the personal category, she was asked to go further and explain what the photo represented to her:

"Oh a typical day, for example, the, umm, the face on the – on the left; the lighter colored white face, says that I wake up really happy thinking that, you know, everything will be great and I'll start a new perfect day, a very efficient day productive and everything; and the – the other side says that, you know, after the first hour I'll probab – I'll there's a chance that I'll get an email that will make me upset or there will be other tasks to do, within – with my, umm, planned day that will bother me 'cause I'll have leave what I'm doing and, umm, it's – it's a – it's a change in the mood, or change in the tasks, or change in the people I see, or I dunno' things – things that – that change from one to another throughout the day."
[Kyra]

The picture of the black and white face which Kyra supplied is not literal, but metaphorical. The photo allows her to speak of her disposition, in that she starts her days out optimistically but her mood can decline as she goes throughout her day and is drawn away by the requirements of her job. She reflects on her interactions with the structure of her job and organization, using the photo as a departure point. The picture gives Kyra a vocabulary to explain her frustrations with having to divide between her personal goals and the demands of her work environment.

Other participants also used their personal photos as a chance to use metaphors to explain facets of their identity. For instance, Grant brought a photo that depicted a monk in a den of tigers:



Figure 4. Grant's "personal" photo for his first photo elicitation interview.

Grant explains that though the tigers are extremely dangerous, the monk is serenely petting them and the tigers are "accepting of his presence:"

"Okay. I think this bottom one ((I: UM-HUM.)) would be the compassionate side of me you know. 'Cause you know this monk is very peaceful, and he's obviously in a den full of tigers and all ((I: UM-HUM.)) the tigers are very you know very powerful beasts, you know animals, you know they could probably tear his jugular out at any given second, but he's sitting there petting them, and they're you know, they're accepting of his presence. So it's kind of like you know the compassion. He has compassion for the tigers, and even being in a very you know dangerous environment, he's very calm. And I feel like, yeah, my personal side I'm very you know, I'd say I'm very sensitive to people ((I: UM-HUM.)) toward other people, and you know and being able to be in an environment and still be comfortable and I mean, I mean this monk is pretty cool looking too. You know he's just sitting there in his robes, and it's a very, I don't know, I like the feel for that picture." [Grant]

Grant uses the picture of the monk and tigers to explain a side of his personality that he values. He appreciates the ideas of compassion and sensitivity he feels the picture conveys, and feels that he also embodies these qualities—something he values in his own personality. He also admires compassion in the face of potential danger or discomfort, if not always literally in the form of a den of tigers. In these comparisons, Grant is using his picture to provide a language to explain aspects of his personality; the monk and the tigers *represent* a facet of Grant.

Two of our participants, Evelyn and Xavier, brought in photos of aircraft. However, they explained their metaphors in very different ways. Xavier saw the plane as representing "perfection," a piece of machinery doing exactly what it was meant to do:

"And I think this aircraft is like perfection in terms of what it was meant to be doing, then the people who designed it in terms of its performance, the way it pushed all kinds of boundaries in terms of operations, design, building it, maintaining it, flying it – in fact, even using it. So it set a new benchmark in

terms of what you can expect from an aircraft. Until then, everything was quite similar. All aircraft were very similar to one another, but this one suddenly stood out as if it's from a sci-fi movie. It redefined the whole landscape. And redefined in terms of excellence or superior quality, those things. So I think professionally that is what I want to be. Just not run of the mill but bringing new things to the table in a really novel way." [Xavier]

Evelyn, on the other hand, explains the photo of the aircraft she brought in as representing getting into "another space"—exploring new frontiers and crossing divides, whether geographic or disciplinary:

"Uh, I guess what it says is that I'm always thinking about traveling and about leaving, ((I: CHUCKLE.)) and about getting – getting into another space and another culture. That's pretty much I – I know it sounds – might sound strange but it's pretty much all that I think about. Even my work that I do, umm, I – I work, umm, with groups across the globe and I'm thinking about when is – when can I go see this person that – that I need to see them in person, I need to see their activities, umm, and I need to get on a plane to do that." [Evelyn]

To Xavier, a picture of an aircraft serves as a departure point to express what he values in his discipline and in his work environment. The aircraft represents a feat of engineering and the amount of teamwork that went into its production. To Evelyn, the aircraft represents what mattered most to her at the time of her first photo elicitation interview—traveling and getting to work with groups across geographic and disciplinary boundaries. Without the participants explaining the metaphor of the aircraft, all that could be gleaned from the photos are that they are of planes. Xavier and Evelyn used the metaphor to individually explain what matters to them.

Not all of the photos had a symbol that was immediately apparent within the actual photograph. While some photos showed images which were then used to describe something important to the participant, Alvin's professional photo served as a starting point for how he sees himself personally and professionally. The photo is of Alvin with a powerful expression on his face (we are not showing it here since it is too identifiable); he has wide eyes and is intensely gazing straight at the camera. There is no apparent metaphor in this picture, but Alvin creates a metaphor based on what he sees in the photo. He uses the metaphor of a "barbarian banging on the gates of Rome," which he sees represented in the photo, in order to explain his approach to his discipline:

"So this one's an important one which is barbarian. So uh, uh, in my discipline in general there's a lot of people with very strong physics backgrounds; and people in my discipline sort of have physics-envy, and they all ideally would like to be theoretical physicists. And so there's a pecking order as there is in many disciplines with you know – people who are more physically based at the top and everybody else is down here. And so I've actually spent a lot of my career as somebody that's not particularly good at the physics end of things either wishing I was better or trying to justify my own existence to people who are better at that

sort of thing. ((I: UM-HUM.)) And one of my mentors basically just craps on me constantly and has for 15 years, umm, but I keep going back for more because he's very smart and very honest. So the only – he's only given me encouragement once or twice I guess in my life, but one of them was umm, by pointing out, as he put it, that it's the barbarians banging on the gates of Rome that actually make Rome change. That it's not the people who are already well established using known techniques, and known methods, and can recite the famous works of their intellectual ancestors; it's not those people who actually make new things happen." [Alvin]

Alvin uses this photo to *create* a metaphor, rather than using the image in the photograph as a metaphor. This process helps him talk about how he feels as though he is an outsider and does not have the necessary skills (e.g., knowledge and expertise in physics) to reach the top of the “pecking order” in his field. He is establishing his out-group identity but also his desire and actions that he hopes will lead him to be a part of the (albeit altered) in-group. The metaphor he creates based on his photo helps offer a more vibrant depiction of how he views himself in relation to his discipline.

Photos support connections between identity and conceptual understanding

Beyond enabling participants to use metaphor to speak more deeply about their identities and experiences, the method of photo elicitation also helps participants articulate relationships between identity and conceptual understanding and among different identity facets. Asking the participants to choose a photo for each of their personal, professional, disciplinary and cross-disciplinary identities allows the researchers to identify relationships among participants' sense of self, sense of community/communities and sense of organizational structure. The photos served as clear reference points when associating the different facets of a participant's identity. For instance, Bernadette spoke about a skills lab in which she, as a student, was placed into a group with classmates, and they were directed to learn about and experiment with soldering. To explain this experience, Bernadette brought a picture of a rainbow bracelet to her photo elicitation interview to represent the personal category:

“So, yeah I mean, they were getting along okay, and they were trying to figure out their stuff and they seemed to be alright with what they were doing. So, I just grabbed another soldering iron and started playing around until they were finished with their stuff.” [Bernadette]

Later, the interviewer asked Bernadette to explain why she chose her disciplinary photo, which is of a “life straw”—a type of straw distributed to developing countries to help purify drinking water. Bernadette uses this photo as a launching point to discuss what she values in her work—namely, comfort (e.g., happiness), having fun, creativity, and flexibility. Part of the way she values flexibility is when she perceives there are multiple ways to reach a goal. Bernadette's actions during her skills lab, when she created the rainbow bracelet separately from her teammates, help highlight how these characteristics impact her actions in her profession (which she identifies as being a student).

Photos as supporting connections between “that kind of person” and “that kind of work”

As a method, photo elicitation also allows the participants to articulate the connections between how they think, how they act, and how they are. These three categories can be difficult to piece apart; the use of photos helps participants access both a launching pad and a vocabulary for doing so. For example, Kyra brought a picture of a brightly colored puzzle as a representation of her professional life. When asked to explain why she chose this picture, Kyra says:

“Sure, I was trying to find a picture that looks more like a problem solver or a puzzle solver, or, you know, trying to fill the gap, umm, and, you know, trying to feel how important it is to fill those gaps, being the right person/the right location kind of thing. I was just, you know, hitting multiple thoughts while searching for this picture, and umm, I actually found this because I told it – it has more potential than – than what I was searching for ‘cause it has all the different colors not just the puzzle pieces – puzzle pieces are representing, you know, solving the problem.” [Kyra]

Kyra uses the picture of the puzzle to explain that she is a problem solver, and therefore she tries to be the right person and to be there at the right time. While the picture helps her speak to how she thinks and how that influences her behavior, she explains that she had multiple thoughts while looking for a good picture to represent her professional identity. The picture serves as a way for her to explain this, as well, as there are a variety of multi-colored pieces which make up the whole puzzle—again, serving as a metaphor for how Kyra sees herself.

Alvin also uses his professional photo to explain how he thinks, acts, and is, and, like Kyra, uses this photo to make a connection to his personal life. Again, we can refer to Alvin’s earlier quote, comparing himself to a “barbarian beating on the gates of Rome.” This comparison represents how Alvin approaches his professional life. He is not an insider of the professional group with which he most identifies, but he thinks about how he wants to be part of that cohort, after he encourages some important changes. Therefore, he acts like a “barbarian,” trying to make the discipline and profession with which he identifies change.

Photos decrease power distance between participants and researchers, and increase agency

In a traditional interview format, the researcher is in charge of the proceedings. The researcher has a protocol, decides what questions will be asked, and generally determines the path the interview will take. In some versions of photo elicitation, the photos are provided to the participants and they are asked to speak about what the photos mean; this limits the freedom participants have in creating meaning. By participants being able to bring their own photos, they get to choose what they want to talk about. In other words, participants have agency in the interview process. The photos serve as “communication bridges” between the participant and the researcher, allowing participants’ meanings to speak through the photo as a representation.²⁵

Some participants took this aspect of the photo elicitation method a step further than expected. For instance, when reviewing the category of each photo she brought to the interview, Alice mentioned:

“I think that was a little harder because for me like I guess I think of what I do every day as interdisciplinary because I work in a lab that’s not my umm, I work in a lab in the pharmacy school, but my discipline is biomedical engineering. ((I: UM-HUM.)) So it’s kind of hard for me to like separate them at times because I’m always in pharmacy but ((I: UM-HUM.)) my discipline’s biomedical engineering.” [Alice]

Here, Alice is asserting her agency in the interviewing process. She was asked to select photos that aligned with the categories of personal, professional, disciplinary, and cross-disciplinary. She did so, but also explained that she felt the categories were restrictive to how she saw her disciplinary identity. She uses the photo as a way to discuss how integral cross-disciplinarity is to her disciplinary life.

As explained before with the differences between Xavier and Evelyn’s pictures of aircraft, while a photo might seem clear to the researcher, it is the meaning the participant assigns to it that is important. For example, for her second photo elicitation interview, Evelyn brought a picture of her and her cat as her personal photo. When probed further about the meaning of the photo, she replies:

“Oh it’s very, very important and I didn’t realize that when I was – when I had initially taken a position where I was travelling a lot, but once I got into it I found that I really missed being at home and being able to have a stable family, if you can call a cat and a husband a family that you come home to every night and that became very important to me. I think that a lot of people as they get older, you know, as they grow from their 20s, their 30s, their 40s, they find that things that they thought were important as a younger person turn out to not be so important and then other things take their place.” [Evelyn]

On the surface, Evelyn’s picture is just a woman and her cat. However, to Evelyn, this photo represents a distinct shift from her earlier photo elicitation interview. In her previous interview she discussed frequently how much she enjoyed traveling and experiencing new things. She described her job as global, and spoke of entering new territories. While this is maintained somewhat in her second photo elicitation interview, she also explains that she is enjoying more work-life balance. The cat, to her, represents the family she and her husband have built together. The method of photo elicitation allows Evelyn’s voice to come through in the interview and allows her to assert her agency; the picture of her holding her cat helps her speak to an important transformation in her life.

Participants also have agency in how they choose to find their photos in this version of photo elicitation. A few participants, such as Grant and Becky, used a Google image search with particular key words that meant something to them. Participants such as Alvin and Evelyn offered pictures from their own personal lives and/or spent the time taking photographs themselves. Some participants spent quite a bit of time finding just the right photos, and in some cases, such as with Grant, brought in multiple photos for each category, thereby asserting agency beyond what was immediately granted in the interview protocol. Bernadette told us she “pulled [her pictures] randomly off Facebook” for her first photo elicitation interview. Regardless of the way participants chose their photos or the amount of effort they put into the process, the method

of photo elicitation allowed participants to *make* that choice. In other words, participants were not restricted by the researcher to only choose photos they had taken or photos that they found online. Participants exercised their agency in providing the points of departure they preferred, rather than the ones the researchers might choose for them.

Photo elicitation reveals progress in ability to articulate identity

Finally, the photo elicitation method supports revealing progress or shifts in participants' capabilities, understandings, and identity over time. As the same categories of photos were requested for each time—that is, personal, professional, disciplinary, and cross-disciplinary—comparisons between both the photos and the explanations are fairly clear. The personal photo from the first photo elicitation interview can be compared with the personal photo from the second photo elicitation interview, connections in the first interview between one photo and another can be compared to connections revealed in the second interview, and so forth.

For her first photo elicitation interview, Bernadette told us she just pulled her pictures randomly off Facebook. In explaining her method in this way, Bernadette somewhat dismisses any effort she might have put into selecting these photos—they were perhaps chosen based on convenience. For her second photo elicitation interview, Bernadette walked us through a detailed process of how she selected her photos. All of them were personally related to her and her identity, and some of them she had taken herself specifically for the interview. This suggests her levels of intentionality and self-reflection increased between the two interviews, and illustrates how the method of photo elicitation helps illuminate this kind of shift.

As explained earlier, photo elicitation also helped reveal the shift Evelyn experienced between her first and second interviews. In her first interview, her personal picture was related to work—she had to take an airplane to reach different corners of the globe and to enter different spheres. In the second interview, her personal photo changed to one of her and her cat, representing to Evelyn her shift of focus onto more of a balance between her work and her personal life. The photos offer Evelyn very clear examples on which to draw when explaining her evolving sense of self and cross-disciplinarity; in her second photo elicitation interview, she refers to how she used to feel and behave, traveling frequently. She then explicitly contrasts that lifestyle with the one represented by the picture of her with her cat.

4.0 Conclusion

Using examples from our study, we hope we have illustrated and verified the benefits of using self-selected photos on eliciting data about what people experience and understand about a phenomenon. For the purposes of this study, the photo elicitation method allowed participants to reflect on their experiences (in the past, in the present, and potentially in the future) and the meanings associated with these experiences – specifically, what it means to be cross-disciplinary and how this relates to other facets of their personal, disciplinary, and professional identities and work. More importantly, the method is allowing us to investigate how and why these identities and conceptions are changing over time.

The summary provided in Table 2 relates arguments for using photo elicitation from the existing literature with the arguments presented in this paper about the specific case of studying

identity development and the process of becoming a particular kind of professional (i.e., a cross-disciplinary professional). As shown here, many of the existing arguments were verified in the examples presented in this paper, with a few exceptions. First, because the study design presented here encourages the use of multiple photos and interview questions that link across photos, we were able to illustrate the ways photo elicitation allows representing ideas as interrelated wholes.⁵³ Second, because of the longitudinal nature of the data we were able to illustrate the ways photo elicitation can reveal shifts in awareness and identity.

Table 2. Summary of utility of photo elicitation research methods

From the literature, photo elicitation...	In this example, photo elicitation...
<ul style="list-style-type: none"> • Helps articulate abstract or complex concepts that have personal meanings • Helps elicit tacit knowledge and subconscious knowing that participations might be hesitant or unable to share • Supports expression of feelings and values, because photos are charged with psychological and emotional elements and symbols 	<ul style="list-style-type: none"> • Supports metaphorical reasoning about the meaning of abstract and complex ideas that may defy traditional words and text • Supports explaining aspects of experiences and what they mean
<ul style="list-style-type: none"> • Allows representing ideas as interrelated wholes • Supports self-reflexivity and sensemaking in context • Enables moving beyond literal content towards reading within and across boundaries 	<ul style="list-style-type: none"> • Supports making connections between identity and conceptual understanding; between “that kind of person” and “that kind of work” (for the case of using four photos representing different identity and work perspectives) • Supports agency in what participants reflect upon
<ul style="list-style-type: none"> • Promotes communication bridges between strangers • Increases agency for respondents versus researcher being in control 	<ul style="list-style-type: none"> • Photos decrease power distance between participants and researchers, and increase agency in how and what participants want to talk about • Enables flexibility and adaptability within the interview structure. • Reveals progress and shifts (if used multiple times over time)

As suggested in the literature review, there are some challenges for using the photo elicitation method. Some of our lessons learned from using this method are not necessarily unique to this method, though some are. For example, like any technique, the method requires extensive piloting; however, unique aspects of the method include piloting the instructions for selecting and submitting photos and managing expectations since participants need to do homework prior to the interview, which may be perceived as cutting into personal time. Like any interview technique this method can also be time intensive. In situations where privacy and confidentiality could be an issue, we found that participants were able to find photos on the Internet that allowed them to talk freely about such sensitive subjects. While the literature suggests that allowing participants to select their own photos may result in less consistent results or more difficult comparisons, we found that having consistent interview questions and probes both empowers the participant and adequately supports comparison across a participants’ set of interviews as well as other participants’ interviews. In addition, our experience further verifies how the surface level content of the photo or the source of the photo does not appear to influence what a participant shares about what the photo means. Finally, while we do not provide a comparison of using this technique over other techniques – other researchers have performed these kinds of analyses and have found that photo elicitation often provides a richer set of data

over other interview techniques.²⁴

We conclude this paper with recommendations for using photo elicitation methods for other kinds of engineering education research questions⁵⁴ and methodologies⁴⁶ beyond studies that seek to bridge identity development with conceptual development. There are, as examples, five different areas in which the method of photo elicitation can be utilized:

- *Engineering epistemology*: Photo elicitation can be an effective technique for studying aspects of engineering that deal with complex and abstract concepts such as innovation, global and cultural competency, engineering thinking (e.g., engineering as problem solving, as design, as sociotechnical work, etc.), and systems thinking.
- *Engineering learning systems*: Studies that seek to understand people's experiences and their associated meanings such as learners' experiences of formal and informal learning environments, inquiry-based learning environments, or technology-enabled learning environments.
- *Engineering learning mechanisms*: Using images may be a useful technique for investigating experiences within organizations and cultures and has been used to study complex and abstract ideas such as taking a systems perspective to transforming STEM education.⁵⁵
- *Diversity and inclusiveness*: Photo elicitation can empower respondents to talk about experiences of oppression and disenfranchisement, and can support exploring intersections across race, class, and ethnicity with becoming an engineer.
- *Assessment and research methodologies*: Photo elicitation can complement other methods,²⁵ particularly other qualitative research methods such as ethnography (highlight aspects of experience in different contexts), grounded theory studies, design-based research (photos as a way to support inquiry), discourse analysis (as socially constructed object), diary studies and narrative analysis, and phenomenography (photos as representative of situation and phenomena).⁴⁶

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