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Global Responsibility in Engineering Education: Student Perceptions and Transformations During an Immersive Experience

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Abstract

Global responsibility is an increasingly important topic in engineering design education. As we confront a range of complex global issues, such as access to clean water, sustainable energy, resilient infrastructure, and equitable technology, there is a heightened awareness of the need for action. Such issues reach beyond the scope of traditional engineering approaches, encouraging a shift in values focused on ethical awareness, adaptive approaches, and international expertise. If these issues are to be appropriately addressed, they require a shift in values towards systems thinking, collaboration with expertise beyond engineering, and engagement with social issues. Many academic institutions and other organizations incorporate immersive learning programs to foster an ethic of global responsibility. One such program is the Engineers Without Borders-Australia (EWB-A) Design Summit, a 28-day international design education experience for undergraduate students in Australia and New Zealand. This research sought to investigate global responsibility in the context of this immersive educational experience. Our key research question was: How do students' perspectives on global responsibility evolve during an immersive design experience, and what factors contribute to these changes?

In collaboration with EWB-A, we investigated a recent Summit that took place in Cambodia. Using ethnographic methods, data was collected data in three ways to triangulate findings: a survey, interviews, and observations/field notes. The lead author conducted pre-summit and post-summit semi-structured interviews with students, asking about prior experience in socially engaged engineering and their perceptions of global engineering. She then attended the Summit as a facilitator while also gathering data through daily field notes documenting daily activities as well as observations and conversations with the participants. Using established qualitative content analysis methods, key themes were identified and related to how engineering students' perceptions on global responsibility evolved over the course of the immersive design experience. Our results are presented across three primary themes: motivations, perceived impactful moments, and levels of immersion. Ultimately, we provide insight into what factors contributed to individual perceptions of global responsibility. Recommendations to support engineering educators to develop globally conscious and socially engaged engineers are provided.

1 Introduction

As global challenges increasingly span disciplinary, cultural, and national boundaries, engineering students must be prepared to successfully tackle diverse, interconnected socio-economic and environmental problems. These challenges are shaped by context, values, and politics that technical solutions alone do not solve. To respond effectively, engineers require

broader skillsets and mindsets that enable them to effectively collaborate across disciplines and to engage thoughtfully with the complexity inherent in real-world problems. In response, higher education has expanded the use of experiential learning approaches, such as project-based and immersive learning, to support broader skill and competency development including cross-cultural communication, community engagement, empathy, open-mindedness, willingness to learn, and curiosity. A common underlying assumption of these approaches, particularly with cross-cultural design experiences, is that students' perspectives on the world, communities that face certain challenges, and their understanding of their own position and responsibilities within it, will shift through direct engagement with communities who face certain challenges and real-world and contexts. As these experiential learning practices become more prevalent, it is essential to critically examine their effectiveness and limitations in achieving these learning goals.

Project-based learning (PBL) emphasizes learning through engagement with real-world problems and the people who are experiencing them. Research suggests that PBL supports the learning of content along with the development of flexible thinking strategies [1], [2]. PBL, and particularly *immersive* PBL, has been shown to positively influence students' perceptions of sustainable practices and the potential role engineering can play in social change [3].

Immersive experiences, particularly international programs, have grown in popularity to expose students to cross-cultural contexts and to foster intercultural competence—the ability to communicate and effectively work with people from diverse cultural backgrounds [4]. Despite widespread assumptions that immersion alone leads to meaningful perspective shifts, research shows exposure to different cultures without intentional pedagogical support is often insufficient in producing desired developmental outcomes, such as the growth of intercultural design skills [5], [6], [7]. Recent studies indicate that immersive experiences have uneven impact, proving transformative for some participants while reinforcing negative preexisting assumptions or biases about other cultures and communities for other students [8]. These findings highlight the need for careful evaluation of immersive design educational approaches, particularly with respect to how and under what conditions they support shifts in students' global perspectives, values, and sense of responsibility.

As such, our goal was to investigate an immersive international undergraduate engineering design experience, with the aim of examining how participants' perspectives on global responsibility evolved over the course of the program. By empirically observing changes in students' perspectives, this work sought to contribute to a more nuanced understanding of the conditions under which immersive design experiences support (or fail to support) meaningful educational transformation.

2 Background

2.1 Global responsibility in engineering education

Global responsibility has emerged as an increasingly important topic over the past few decades. As our world navigates polycrises including climate change, inequality, poverty, and more, there is a heightened awareness of the need for engineering practice and education to support sustainable development efforts [9], [10]. These complex issues reach beyond the scope of traditional engineering approaches, encouraging a shift in values to focus on systems thinking, ethical awareness, adaptive approaches, and international development expertise [11]. While scholars increasingly advocate for changes in curricula [12], many engineering institutions do not require courses that support students to learn the skills necessary to address complex, interdisciplinary problems.

However, there is growing recognition that engineering 'problems' and 'solutions' are woven with social and ethical considerations that engineers are not trained to handle [13]. In response, there have been increasing calls for engineers to develop and practice humility, particularly given that they are not traditionally trained to work in development contexts or across cultures [9]. Empirical studies suggest that engineers who demonstrate higher levels of humility are more open to learning about and integrating contextual factors into their design processes [14], and that humility contributes to stronger team dynamics and greater trust among collaborators [15]. In engineering, *global responsibility* has been defined and operationalized in multiple ways across organizations and scholarly work. Engineers Without Borders (EWB) U.K. defines global responsibility as "critically reflecting on the role of engineering in society and understanding the social, environmental and economic impacts engineering has, both locally to where it is implemented and globally through supply chains and operational outputs" [16]. Similarly, EWB-Canada has advanced the concept of the "global engineer" to encourage greater socially conscious and cultural awareness in the field [17]. Prior research has further explored what it means for engineers to act in globally responsible ways, often framing global responsibility in terms of ethical awareness, professional and cultural competencies [18], [19]. In this sense, global responsibility can be understood as a professional standard that holds engineers accountable for the broader impacts of their work on communities and society—both positive and negative. However, the concept remains contested, with varied definitions and multiple frameworks across contexts. For example, in the United States, there is a history within the engineering field that promotes a code of ethics when it is advantageous for business interests and shareholders, creating barriers to addressing broader social and environmental concerns, and oftentimes contributing to socio-environmental issues [20].

Today, universities increasingly value and incorporate global responsibility training, such as through workshops, coursework, or extracurricular activities. Some engineering programs offer

immersive and field-learning experiences, such as summer practicum projects, that require students to engage directly with communities and deepen their understanding of global responsibility [21]. Prior studies have assessed students' perceptions of social change, sustainability, and cultural competency, indicating that project-based and field-learning experiences can significantly shape students' perspectives, grow their appreciation, and contribute to the development of appropriate solutions in engineering [8], [22], [23]. However, there still exists a lack of understanding of the perspective shifts that engineering students experience as they develop their sense of global responsibility.

2.2 The EWB-Australia design summit

The EWB-Australia Design Summit ('the Summit') is a 28-day professional immersion program that provided our research team with the opportunity to study students' experiences and perceptions of global responsibility in an immersive design program. On average, EWB-Australia hosts Summit trips twice a year, with 1500 students participating in the program since its inception in 2015. EWB-Australia has long-standing partnerships with community organizations in multiple countries, and Design Summits have been held in Cambodia, India, Nepal, Malaysia, Timor-Leste, Vanuatu, and Samoa.

A recent EWB-Summit took place in Cambodia. The trip was organized as a four-week immersion, organized into three phases. In Phase 1, participants spent a week in the capital, Phnom Penh, focused on stakeholder perspectives and experiences as engineers, professionals and development workers, skill development workshops, and learning Cambodian culture and language. This included meeting with government officials and non-profit organizations, participating in interview workshops, and conducting multiple historic site visits, including two genocide sites, S21 Killing Fields, and Tuol Sleng. These sites are central to Cambodia's recent history, shaped by thirty years of civil war just a few decades ago. These sites are important not only for understanding the nation's past, but also for recognizing the lasting impacts and consequences on its development, society, and culture today. The next two weeks (Phase 2) involved homestays in a local village, staying with families, and eating at a communal 'main house.' During these two weeks, the students worked with interpreters to interview villagers and learn about local context and design opportunities. The second week focused on generating design solutions and students were divided into teams. Phase 2 concluded with presentations of the design solutions to the community and a celebratory goodbye. The final week (Phase 3) was spent in Siem Reap, the second biggest city in Cambodia. Phase 3 programing was filled with debriefs and reflections on the trip. This organization of the program was created to reach the program's goals of providing an opportunity for transformational learning:

> "The EWB Australia Humanitarian Design Summit is a once-in-a-lifetime opportunity for an immersive learning experience outside the classroom. Over 28 days, you'll push your boundaries, gain insights into best-practice community development, and appreciate the role engineering plays in creating positive change. You won't come back the same person (in a good way)." [24].

2.3 Theoretical foundations: Transformative Learning Theory

Transformative Learning Theory is a theoretical framework developed in psychology that seeks to explain how changes in perspectives and assumptions occur in adults. This theory centers on critical reflection of one's beliefs and presuppositions and is characterized by ten phases from "experiencing a new situation" to "integrating a new perspective into their life" [25], [26], [27]. This theory has been used to understand the development and evolution of people's belief systems, and make meaning of their experiences [28]. To explore the change in perspective of Summit student participants, we chose to apply Transformative Learning Theory.

3 Methods

3.1 Research question and overall approach

To investigate how students' views of global responsibility transformed during a specific educational experience, we worked to address the research question: *How do students' perspectives on global responsibility evolve during an immersive design experience, and what factors contribute to these changes?*

To address our research question, we used an ethnographic case-study approach to explore the individual experiences of three participants in-depth [29]. We conducted a pre-Summit survey to gather participants' motivations, background context, and demographics. We then conducted pre-, during-, and post-Summit interviews with each participant to observe shifts in perspectives on global responsibility overtime. Field notes were also collected over the course of the entire program. We chose to use a qualitative content analysis method to explore shifts in perspectives and identify recommendations for educators who implement immersive design programs [30]. This study was reviewed by our university's Institutional Review Board and determined *exempt level two* (25-0250).

3.2 Recruiting participants

We used a purposeful sampling technique [31] and invited all 31 Summit students to participate in our study. All potential participants were undergraduate students at universities in Australia. Participating in our study was optional, and seven students consented to participate. For this

analysis, we focused on three participants, which we selected based on the depth and completeness of their collected data. All three students completed the pre-survey, participated in all interviews, and participated in extra forms of data collection during the summit (e.g., debriefs, follow-up discussions), providing us with more insights to evaluate and a deeper analysis of their perspectives. The use of Transformative Learning Theory requires in-depth analysis and holistic views into the participants' experiences, encouraging a smaller quantity of case studies for in-depth analysis [25], [27]. Names have been changed to pseudonyms and identifying details have been generalized to ensure anonymity and confidentiality.

3.3 Data collection

For this study we used three forms of ethnographic data collection methods: interviews, surveys, and observations/field notes [32]. Ethnographic methods offer a comprehensive understanding of social phenomena and beliefs, compared to solely using interviews. Ethnographic methods are aimed to provide holistic insights into people's worlds, and understand how individuals' perceive and experience specific phenomenon [33], [34]. To understand how our participants viewed global responsibility and other perspectives, we triangulated our data from surveys, interviews, and field notes/observations. Triangulating data provides for a more in-depth analysis [35].
The focus of this study involved observing and participating in the most recent EWB-Australia Educational Design Summit: Engineering for Equitable Climate Transitions. The data used in this study were gathered by the first author (hereafter referred to as the "lead researcher"), who supported Summit preparations with EWB-Australia and then attended the entire Summit. The lead researcher is a doctoral student in a mechanical engineering in the U.S. with a focus on global engineering. She received training in human-centered design processes, qualitative methods, ethical community engagement, global development, and other related skills prior to participating in the summit and conducting this study. Her work preparing for the Summit with EWB-Australia, included, but was not limited to, developing activities, attending safety briefings, and participating in meetings on expectations and goals. She then attended the Summit in its entirety, helping facilitate activities, lead workshops, and lived communally, experiencing the same daily activities as the participants. To understand the perspectives of the students throughout the Summit experience, the lead researcher conducted three stages of data collection using different data collection methods.

Part 1: Pre-summit interviews and survey data

Before the students attended the summit and left their home country, the lead researcher conducted a survey and pre-summit interviews. The survey included questions on demographics, prior experience in the humanitarian field, and views on global responsibility. These questions gave us a general understanding of the students' background and a baseline on their motivations and familiarity with their perspectives before conducting a pre-summit interview. This interview

followed up on their initial view of global responsibility, previous university coursework, experience in humanitarian engineering, and initial thoughts or assumptions about the Summit (Table 1).

Table 1. Outline of Pre-Summit Interview Protocol

Introductions, Rapport-Building, and Background
In the survey, you mentioned you are a [x] year in school, and major in [x]. Can you talk about the kind of classes you take/have taken? Can you tell me about any other relevant experience and current work?
Deep Dive into Global Responsibility Perspectives
When you hear the term "global responsibility" - what does this make you think of / what does this mean to you? What skills/knowledge/competencies do you think responsible engineers need? In what ways does/ has your degree/engineering studies at university provided you with these skills/competencies you need to be globally responsible? Can you tell me about any other experiences/courses or training that have supported you with the skills/competencies you need to be globally responsible? Do you have an instance in your recent work as an engineering student where you made decisions related to 'global responsibility'? Can you describe a time when being globally responsible has/could present challenges? What opportunities do you see by incorporating global responsibility more?
Conclusion
Can you tell me why you are participating in the Summit? What are you hoping to gain from this experience? Any specific skills or competencies? Anything else you would like to share that I haven't asked about?

Part 2: During summit observations, field notes, follow-up interviews

During the Summit, the lead researcher was an active facilitator in activities, helping aid in workshops, supporting students, and being equally immersed in the Summit. During the program, she lived in similar housing, ate communal meals, and participated in all mandatory and optional activities with the students. Her active participation allowed her to obtain consistent observation data and field notes and to develop relationships with the students, collecting observations and field notes throughout the Summit.

Part 3: Post-summit interview

One month after the summit concluded, the lead researcher conducted interviews with the student participants, reviewing questions that were asked in earlier surveys and interviews, and asking them for reflections on the program, the experience, knowledge learned and general

observations. An outline of our post-Summit interview guide is shown in *Table 2.* This allowed our team to uncover the students' perspectives post-summit, after a few weeks of integration into their daily lives and they settled back into their routines. While certain final reflections were recorded as observations and field notes, we were able to understand students' perspectives as they debriefed and said parting words to each other and the program, it is notable that perspectives within an immersion and post-trip can drastically vary between participants. The post-summit interview allowed us to gain perspective into their view on global responsibility after being out of the environment of the Summit and integrated back into their daily lives.

Table 2. Brief Outline of Post-Summit Interview Questions

Warm-up and Background
You recently spent 28 days in Cambodia for the EWB Engineering Summit, can you talk about the activities you did? (workshops, community building, etc.) What were the goals of this work? What were the main takeaways from this experience?
Deep Dive into Global Responsibility Perspectives
When you hear the term "global responsibility" - what does this make you think of / what does this mean to you? What skills/knowledge/competencies did you work on during this summit? Was global responsibility discussed during this summit? In what ways? Did any lesson or skill align with what you've learned in school courses? Did any lesson or skill contradict or differ from what you were taught in school? Were there any lessons or skills that were completely new to you? Describe your confidence level in practicing global engineering skills?
Conclusion
How would you describe the impact of the summit? What skill/lesson stuck out to you? What experience/moment had the most impact on you? How has your understanding of global responsibility changed over the summit? What role does global responsibility have in engineering? If you could change one thing about the summit, what would it be?

3.4 Data analysis

We chose a case-study approach [29], focusing on the unique experiences of three participants. Similar methods for data collection and analysis were applied to each participant individually. All data related to each participant were organized into single documents (one per participant), which included transcriptions of any audio, typed-out field notes, and survey responses. This compilation allowed us to methodically review all data collected on each student and perform thematic coding to the entire dataset.

To explore each student's experience, the lead researcher conducted qualitative content analysis [30], identifying themes and categories throughout the data. She then applied a thematic coding approach to inductively identify themes, and mapped those themes to codes derived from Transformative Learning Theory phases (Table 3) [27]. Applying this theory allowed us to understand the phases of learning the participants were experiencing, and the transformation journey that occurred.

Table 3. Ten Phases of Transformative Learning, Summative Table derived from Mezirow (1978)

Phase 1	A new situation
Phase 2	Self-Examination, Self Reflection
Phase 3	Assessment of assumptions (knowledge, culture, societal, etc.)
Phase 4	Recognition of a shared transformation, others have experienced this
Phase 5	Options for new actions, roles, relationships
Phase 6	Planning action steps
Phase 7	Knowledge and skill acquisition
Phase 8	Trying new roles
Phase 9	Building self-confidence and competence in new roles
Phase 10	Reintegrating into life with a new perspective

To illustrate the view of the participants pre-Summit, we chose to share their initial perspectives through narrative form. This allowed us to showcase the significance of each event as it relates to a larger picture [36], [37].

3.4.1 Analysis of motivations

To analyze we collected data on participants' motivations through both survey responses and interview questions. The summit attracted a self-selecting group of students with diverse goals and expectations. In the pre-summit survey, we asked participants three questions related to motivations for signing up for the summit:

1. "Why are you signing up for this Summit?"
2. "What skills/experiences are you hoping to gain from this?"
3. "What's motivating you to learn these skills/competencies?"

We used the responses from this data collection to inform our findings about the participants motivation, and contribute to our analysis of each participants experience.

4 Findings

Our findings are organized by analysis and theme, with detailed shifts in participants (Noah, Andrew, and Emmett). Each student has come from different backgrounds, with changing motivations and perspectives, influencing how their perspectives on global responsibility evolved. Through the sections below, we explore the individuality of each participant pre-summit, and their shifts in perspective on global responsibility throughout the immersive experience.

4.1 Summary of participants background and motivations

Each participant included in this study came to the Summit with unique backgrounds and motivations for attending. In this section, we highlight the differences in demographics, personal narratives, and stated motivations for each participant. These differences appeared to shape distinct perspectives, attitudes, and assumptions that were later shared throughout the Summit.

4.1.1 Participant background

The participants' backgrounds differed, while they shared geographic and educational similarities, their fields of study, travel experience, and humanitarian engineering exposure were inconsistent across all students (Table 4).

Table 4. Summarized demographics of all participants

Participant	Degree Program Year	Field of Study	Travel Experience	Humanitarian Engineering Experience
Noah	4th	Electrical engineering	Semester abroad; personal travel	Humanitarian design project (coursework)
Andrew	4th	Civil engineering	Minimal personal travel	EWB regioneering trips outreach programs
Emmett	3rd	Aerospace engineering	Lived internationally	Pre-summit workshop (coursework)

Through the collection of survey data and semi-structured interviews we summarized the participants background using narrative configuration to uniquely illustrate their history [38].

4.1.2 Noah's background and motivation to participate

Noah's Background: At the time of this study, Noah was a fourth-year undergraduate electrical engineering student at a large public university in Australia. Prior to the Summit, he completed courses focused on energy systems, math, physics, a senior electrical capstone project, and had personal experience in off-grid power systems. When asked about his education in university, he

described his courses as “very technical,” with one outlier class that introduced human-centered design and culturally appropriate solutions. The course was run by EWB-Australia and involved a humanitarian engineering competition amongst universities across the country. Prior to the Summit, Noah had not participated in any on-site humanitarian work before but had previously traveled overseas. Alongside a semester of education abroad, he also had an experience through personal travel and lived internationally for one month. To prepare for the Summit, he listened to over thirty hours of history podcasts about Cambodia to understand the history and background of the culture. He described learning about the Khmer Rouge, the recent genocide in Cambodia, and current world events. He reflected on his privilege, explaining that having traveled to lower-income areas in other countries, he explained that this influenced how he “…viewed his place in the world.” and the economic privilege that he had.

Noah’s Motivations to Participate: Noah described being motivated to participate in the Summit because of his experience in travel and immersion, alongside wanting to develop skills, implement solutions, and gain field experience. Overall, Noah was really motivated by the opportunity to travel while building engineering skills. He shared,

> “Yeah, just more experience in other cultures. I really enjoy traveling…I like to stay put and try to understand a few things about where I am. So you know it's a great experience to get some of that knowledge. And then on a professional level I think yeah, experience with the user-centered design as EWB's all based around... As I mentioned before, I haven't had to do anything yet in my course. I haven’t had to actually implement anything, so I think it's a great opportunity to be able to do that and try to build on the skills that I want to develop.”

4.1.3 Andrew’s background and motivation to participate

Andrew’s Background: At the time of this study, Andrew was a fourth-year undergraduate civil engineering student with experience in infrastructure and structural design and held a leadership position in his university’s EWB chapter. He described his courses in university as a range of required courses, with a large focus on structural design, and the inclusion of ethics and economics courses, as well as a focus on communication and teamwork within engineering. For his major, Andrew was required to take an ethics course or an economics course. He explained that he chose “…the more ethical one.” and took one ethics course across all four years of classes. He valued the teamwork and communication skills he learned in both his classes and capstone project. Andrew also completed the EWB challenge course in his first year, covering material considering stakeholder management and project management. He mentioned that although his schooling in primary and secondary school did not cover Cambodian history, he had a limited knowledge of some historical events due to his personal interest in history. His involvement of his university’s EWB program led to multiple trips to rural areas of Australia,

teaching engineering to different audiences, demographics, and outreach programs. He elaborated on these experiences and the interpersonal skills they helped him build, working with new audiences and new locations. He explained that he had also worked customer service jobs in the past, where he developed his listening skills and ability to understanding customer needs. However, the experience with the EWB chapter at his university furthered these skills, and he gained an understanding of working in cultures and locations that are unfamiliar. “If I’m not a good engineer—what’s going on?” Andrew responded when asked about how his classes and experiences have been helpful to his development.

Andrew’s Motivation to Participate: Andrew explained that he wanted to experience a new culture and contribute to a better world. He described,

> “I was inspired in my time with the [university EWB] chapter to really contribute to creating a world where technology benefits all, and so contributing to that mission has become a huge passion of mine... I've always wanted to help society. I just wasn't familiar with EWB itself. …we're so privileged in Australia. And I guess that's another reason why I wanted to come on this trip is to experience another culture where they might not have the same privileges that we have and contribute in any way I can to spreading my knowledge and experience and the technology that we have to apply it to a different culture and economic status…I hope that it acts as [a] springboard to continue my work in other countries.”

Andrew elaborated on this, explaining that he wanted to make the world a better place “beyond the borders of Australia” and that this trip would be a steppingstone to build his knowledge of ethical practices in engineering and the confidence to travel.

4.1.4 Emmett’s background and motivation to participate

Emmett’s Background: At the time of this study, Emmett was a third-year aerospace engineering student, with experience in aerospace materials, thermodynamics, and common technical engineering courses. His university emphasized systems engineering as an additional component of all engineering degrees, which in the Australian context focuses on project management, stakeholder analysis, and engineering ethics. Considering the emphasis on systems engineering, Emmett described feeling experienced in these areas alongside his technical courses. He also had the space in his courseload to complete elective courses, adding environmental engineering classes to his schedule. Having taken courses in aerospace engineering, systems engineering, and environmental engineering, he described his overall courseload as “very technical.” As we talked about the upcoming Summit and humanitarian engineering, he mentioned he had no previous experience in the subject area but did live internationally for two years as a child. His international experience made him feel comfortable about going overseas again, and he spoke

with confidence about the prospect of living in a new culture since he already had a positive experience doing so.

Emmett's Motivation to Participate: Emmett explained how he was not specifically motivated to learn any specific skills or competencies during the Summit, but his confidence in living internationally and having that experience led to his eventual application. He mentioned the want to move away from something as a reason for signing up rather than to move towards strengthening specific skills. He described,

> "I signed up because I wanted to get out of [my college town] …[the Summit] counted as a uni[versity] class, which was part of my motivation to go… [And I wanted to] apply my engineering skills, apply what I've learned, in a different environment….. [and] just engage with stakeholders a bit more, be in the community… I didn't really expect to be here. What [am I] actually doing? I'm having a good time. I don't really know the specific skills I'm gonna get out of it, but I'm sure I will get something."

Emmett explained that his first choice for the semester break was an internship, but after those plans fell through and he was accepted to the Summit, he was excited to see what this opportunity had to offer.

4.2 Transformative Learning Theory and global shifts

Below, we show three figures displaying the phases of Transformative Learning Theory applied to the data collected, and the number of instances we identified that a participant experienced related to a specific phase (Figures 1-3). The graphs show the variability of each phase identified, and the stages that are spoken about more frequently. This gives us insights into the unique experiences each student had and the effect the Summit had on them, with certain phases more common across all participants.

Applying Transformative Learning Theory to the data collected for Noah showed high instances of learning knowledge and skills (Figure 1). Secondary to *Learning Knowledge and Skills*, he described many moments of *Self-Reflection* throughout the experience. Although he mentioned other instances of Transformative Learning Theory, we recorded no mention of perceived *Options for New Roles, Planning Action Steps,* and *Trying New Roles.*

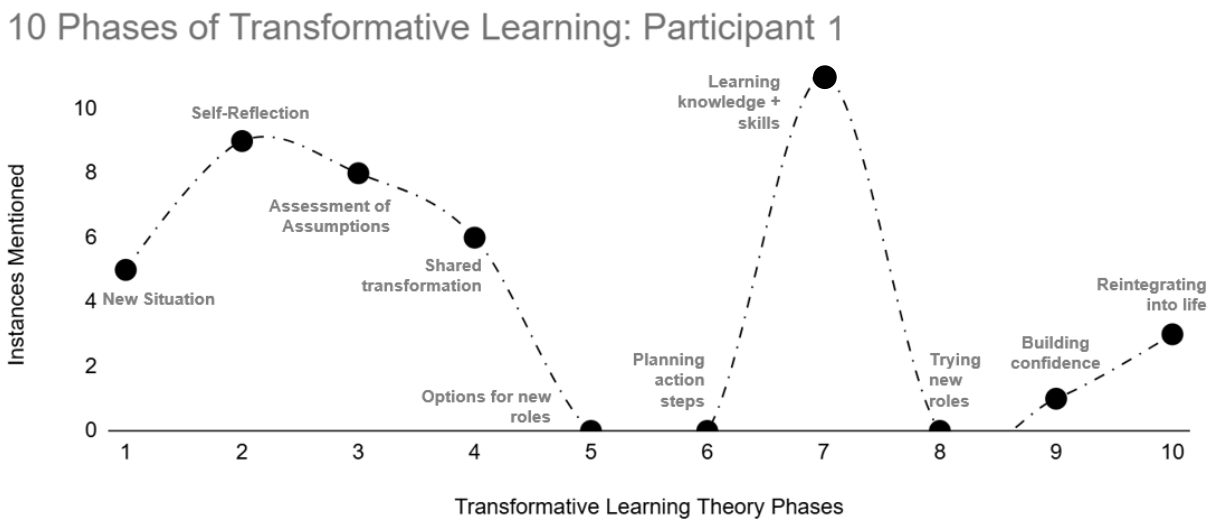

Figure 1. Noah's Phases of Transformative Learning during the Summit, identified through data collection and instances mentioned

Using the same analysis techniques, we applied Transformative Learning Theory to data collected for Andrew (Figure 2). This illuminated *Learning Skills and Knowledge* as the most common instance mentioned, with *Assessment and Assumptions* as the second most common instance. Similar to Noah, Andrew had no mention of *Options for New Roles* and *Trying New Roles.*

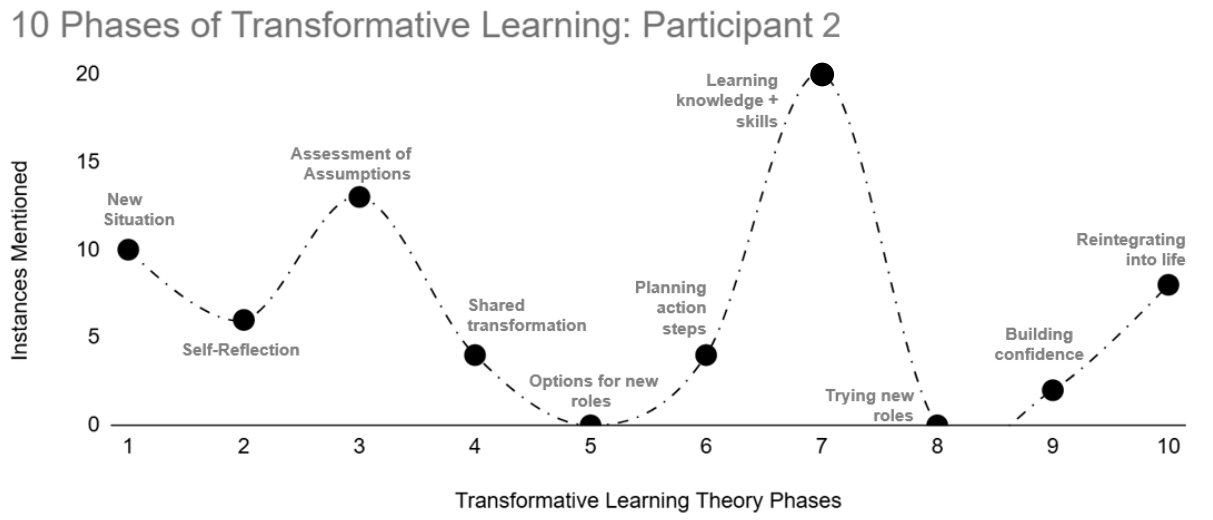

Figure 2. Andrew's Phases of Transformative Learning during the Summit, identified through data collection and instances mentioned

We analyzed Emmett's data with the same methods, exploring the relationship between instances mentioned of phases of Transformative Learning Theory (Figure 3). Emmett's data shows the

highest number of instances during the *Assessment of Assumptions*, and secondly in *Reintegrating Into Life*. We recorded no mentions of *Options for New Roles*, *Planning Action Steps*, or *Trying New Roles*.

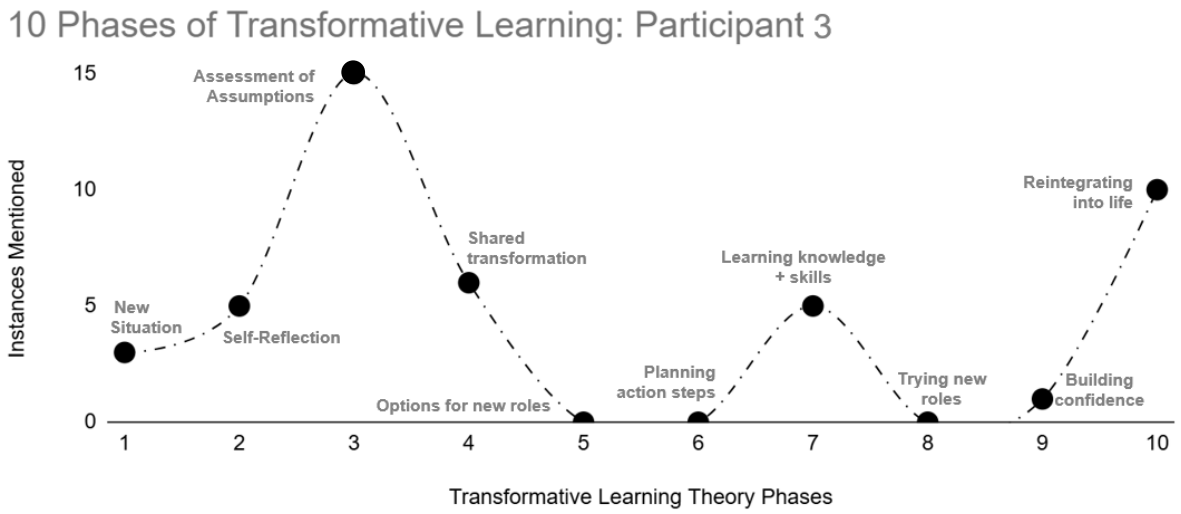

Figure 3. Emmett's Phases of Transformative Learning during the Summit, identified through data collection and instances mentioned

4.3 Global perspective changes

Drawing on data collected before, during, and after the Summer, we uncovered shifts in participants' perspectives across the experience. These perceived changes are detailed in the following section.

4.3.1 Noah

Our findings show that Noah's perspective observably changed from framing *development* as the priority of global responsibility to a perspective that focuses on *understanding cultural differences and making connections with others*. Noah's shift appears to be linked to his willingness to critically reflect on and reassess his assumptions, a process that supported his learning as he engaged with new knowledge and skills.

Noah's reflections on global responsibility before the summit

Noah presented the role of global responsibility for engineers as one's ability to adapt across contexts and have empathy for those who are different from you, especially if they will be affected by your decision-making. He was reflective in his responses, and remained largely general when describing the state of the world and how people behave in it. When asked what

global responsibility meant to him, Noah spoke about the "collective responsibility to empowering everyone" and that those who are privileged are responsible to help those who are in worse positions, "because they can." He described global responsibility through his perspective as an Australian electrical engineering student; he claimed,

> "[Global responsibility is] a shared responsibility for the betterment of everyone…Coming from a very developed country, it's part of that responsibility of having that leg up is then assisting less developed countries, less developed areas… You have developing countries at the moment that are entirely coal powered, and I'd say it's probably in everyone's best interest if we assisted in a transition to renewable energy."

When asked if he believed there were any barriers to integrating global responsibility in engineering, he brought up two key points. The first barrier he identified was the lack of connection with unfamiliar others. He pointed to social media as contributing to this disconnect, noting that "[with] everything being accessible all the time online, a lot of people don't have connection with people, they don't have an empathetic view." He brought up other current political events that face the same challenges, "I think the whole Gaza situation and the whole Ukraine situation is a great example of that where you aren't directly affected, so it doesn't worry you. So I think a big barrier is empathy with the public and a global connection." The second key point he related to his field in energy, explaining that the transition to green clean power faces economic and political barriers where "…all the people who are making decision are taking money in the back pocket from the ones who don't want that to happen…which happens in a lot of sectors." To incorporate global responsibility practices, specifically to Cambodia, he talked about the importance of going into the community without assumptions and ensuring that engineers have adaptable beliefs and are flexible when thinking about problems and the impacts on end users. Finalizing the conversation on global responsibility, Noah brought up the importance of community responsibility, "…assessing every person who's going to be affected by that and then working out what that consequence would be for them. So it's not always on a global scale, but it's more community responsibility, which then, when it gets to a certain scale, becomes global responsibility."

Noah's shifts in perspectives of global responsibility

Throughout the Summit, and in his post-interview, Noah experienced multiple "new situations," such as interacting with locals and being in a close living environment with the other participants. Noah reacted to these situations in reflective ways and was open to assessing his assumptions. He also spent time finding the similarities between cultures, with anecdotes of his own experiences aligning with those of a different demographic and finding common ground. During a day of exploration on Phnom Penh, he described his conversation with his tuk-tuk

driver, describing a political climate that didn't reflect the values of the population "…that was, once again, another perspective moment of similarities between countries in terms of how people feel back home." Throughout the trip, he reflected on his view of privilege, starting the trip saying he was "consciously aware of my privilege, which has become more apparent since getting here." Throughout conversations during experiences and group debriefs, he continued to grow his perspective on privilege and added, "It was very contextualizing in the way that it made me understand better where I fit in the scheme of things." Our analysis did not identify any experiences in phases 5, 6, or 8 of the Transformative Learning Theory. However, we did uncover many instances of learning, such as increased cultural understanding, the development of interviewing skills, and growth of social skills. He described that the biggest lesson that stuck out to him was the relationship between happiness and having things, he shared,

> "…the biggest one that stuck out to me would just be how people that we met…the vast majority of people that lived there, were so happy while having so little. I think that was something that I definitely knew about and I understand, but until you see it firsthand, you don't quite understand the gravity of it."

4.3.2 Andrew

Andrew's overarching view of engineering as a responsibility to use knowledge for societal benefit remained consistent throughout the Summit. However, he described growth in key areas, including confidence with travel, interviewing skills, and ability to work with interpreters. When applying the Transformative Learning Theory to the data collected, we see increased instances in skills learned and assessment of assumptions reflecting growth in these specific areas (Figure 2).

Andrew's reflections on global responsibility before the summit

When discussing global responsibility, Andrew described it as "an obligation to contribute to the betterment of the world, outside of the confines of our homes, spreading the privilege of knowledge [from university] and experiences we have gained to all that we can." He explained that he had never been confronted with the term "global responsibility" but had heard of its use in engineering as an obligation to be fulfilled. He described communication as a barrier to achieving global responsibility and the importance of listening. Having an open mindset and listening to communities can produce the solutions that are best for the society, not just the most efficient he explained. Relating global responsibility to his own experiences, he explained how, as an Australian, he was aware that going into a new culture and society can be confronting and sometimes hard to adjust to. Considering this, Andrew described how actively listening, dialing back cultural assumptions, and taking context and surroundings into consideration can help.

Andrew's shifts in perspectives of global responsibility

Andrew experienced multiple phases of the Transformative Learning Theory during the Summit (Figure 2). Early in the Summit, Andrew explained that a part of global responsibility was to "…spread the privilege of knowledge." This perspective emerged continuously throughout the Summit, concluding with the importance of actively using your knowledge and experience "…for the betterment of yourself in your own area, but also to other and other parts expands to everyone." Throughout the Summit, Andrew brought up multiple action steps to incorporate his new knowledge and skills into life after the Summit. He reflected, talking about shaping conversations with friends about important topics and the ability to create community in his daily life. Bringing these values forward, he explained the importance of incorporating what he's learned and growing from this trip, "I'll be more conscious of things." Andrew reflected broadly on the experience, referencing it fondly and the general impact it to him, "The whole trip itself was a major impact…We were so immersed into their lives, it was so special." He ended the interview with these reflections, explaining that the time in the village, and being completely immersed into daily lives helped him grow his understanding of other cultures and develop new skills.

4.3.3 Emmett

While our analysis indicated that Emmet examined some initial assumptions related to economics, policy, and infrastructure, final interviews indicated that some biases remained unchanged after the Summit concluded (Figure 3).

Emmett shifts in perspectives of global responsibility

Emmett experienced multiple phases of the Transformative Learning Theory during the Summit, as seen in Figure 3. Throughout the Summit, Emmett consistently brought up assumptions that he was confronted with, including the confusion of local economics, and differences in policy. He described perceiving the country as "backwards in the way I think about being backwards" and gave examples such as the differences in road safety policies. He also raised confusion about infrastructure, noting that there were no large gas or oil fields and therefore little apparent incentive for investors to commit capital to the city. He framed these observations negatively, often positioning Australia's practices as superior. These assumptions seemed to compare systems and practices between Australia and Cambodia, and this was a theme throughout debriefs. Emmett explained that he learned interviewing skills during the trip, a workshop that was not offered at university, but didn't gain other skills "Other than that, to be honest, I don't really think I gained a whole lot from a skills side of the trip."

Emmett's reflections on global responsibility before the summit

During our conversations about global responsibility, Emmett gave a few different definitions. He explained that "Global responsibility is the idea that everyone is responsible for the world that we live in and it's our responsibility to look after it and make sure it is in suitable condition for future generations." He expanded on this concept, explaining that every action affects others and emphasizing the importance of considering what stakeholders value and need, rather than focusing solely on optimization. This idea was first introduced to Emmett through a Nationwide Broadcast about recycling when he was younger. He described watching the show and having a takeaway of "everything I'm doing is having a difference." This formed his understanding of a type of responsibility to the world, and the influence that little actions can make on the world. We continued the conversation on global responsibility that led into a discussion on his engineering career aspirations. "I'm happy to lose my moral and go build missiles," Emmett joked, and then backtracked. He explained how he was interested in how bombs work, and how they function, but that it was important to consider what they're used for. "If I build bombs, is it productive to society?" he asked as a rhetorical question. He wrapped up the conversation stating that he felt it was important for engineers to have good morals, and a conscience to be globally responsible, and be aware of the impacts of what they have made.

5 Discussion

Our analysis addressed each participant's perspective shifts on global responsibility, their perceived role in the world, and reflections on the impact and design of the Summit. Our analysis identified key findings related to immersive engineering education and transformative learning opportunities.

5.1 Perspective shifts in global responsibility in engineering

Our analysis revealed both shifts and reinforcements in students' perspectives of global responsibility in engineering. Across participants, we observed that initial framings of global development were broad and often hierarchical, emphasizing obligation, economic privilege, and responsibility of those in "developed" nations to help others. These early definitions relied on generalized language (e.g., "everyone," "the world") and focused on development (e.g., increased infrastructure, resources) over social, cultural, or environmental considerations. Using the term "developed," and similar language, implied certain places are "undeveloped," which is laden with hierarchical assumptions [39]. While we did not observe noticeable shifts in terminology used, we observed variation in the extent to which students' perspectives shifted, particularly with regard to the recognition of the social, cultural, and ethical contexts shaping engineers' responsibilities.

Findings from Noah's case illustrated a clear shift from conceptualizing global responsibility as an abstract and generalized idea toward a more nuanced and relational understanding. He emphasized that global responsibility is less about providing solutions to others and more about understanding and engaging across cultural and social differences. Rather than framing global responsibility strictly as an obligation imposed by one's status, he began to describe it as an opportunity to engage thoughtfully and ethically with others.

In contrast, Andrew and Emmett demonstrated less transformative change. Andrew's core view of global responsibility remained consistent—that engineers hold responsibility to apply their knowledge to improve others' lives. His language shifted and his post-Summit reflections incorporated more contextualized terminology and understanding, "Some of the activities we did…[were] very confronting, very shocking to hear all the stories, all the testimonies. But I think it was really good to understand the context of why things were the way they were." Meanwhile, Emmett's perspective appeared primarily reinforced rather than transformed, as he framed the Cambodian context as confirming preexisting assumptions about skill capabilities, in line with deficit thinking, and reported little perceived learning from the experience [40]. He described living at home post-summit being "grateful, because it could be worse," directly referencing living in the community, and went so far to say that he "learned almost nothing" from the experience. Collectively, these results suggest that transformative shifts in students' perspectives on global responsibility are contingent rather than guaranteed. It remains clear that individual, contextual, and experiential factors shape how students engage with and interpret global responsibility during immersive design experiences.

5.2 Perspective shifts on privilege

The concept of *privilege* emerged organically across our data and was not explicitly prompted in interview or survey protocols. Regardless, each participant independently referenced privilege when reflecting on global responsibility, often in relation to their own positionality and that of their home country. Reflections during the Summit indicated that students became increasingly conscious of their individual role and perceived advantages through lived experiences and interactions with community members. Participants used varying definitions of privilege throughout the Summit, often framing it in economic or material terms and less frequently recognizing social, environmental, or cultural dimensions. This limited understanding of privilege suggests a potential gap in adopting a more holistic perspective, which may constrain engineers' ability to engage in fully responsible design practice.

Participants' invocation of privilege often occurred alongside economic hierarchical framings of global responsibility. Participants tended to position responsibility as flowing from those perceived as more privilege to those viewed as less privileged, implicitly linking global responsibility to differential access to resources, knowledge, and opportunity. In doing so,

students intertwined understandings of certain privilege with conceptions of responsibility, framing global development as an ethical obligation shaped by relative advantage. This pattern indicates that students did not merely recognize privilege as an economic condition, ignoring social, environmental, and other factors, but actively used it as a lens for interpreting engineers' roles and responsibilities in global contexts.

5.3 Impacts of program design on student learning

The impacts of the design program can be examined in two complementary ways. First, applying Transformative Learning Theory enables identification of phases that more prominently reflected in students' experiences, as well as phases that were less evident or absent. Second, participants consistently offered personal reflections on their experiences, including perceived impacts, meaningful moments, and suggestions for improvement aimed at enhancing the program. *Skill-building* was the most identified phase of transformative learning in our analysis. This suggests that supporting students in developing design competencies, such as interview skills, stakeholder analysis, and cross-cultural communication, encourages perspective shifts. In fact, nearly all training and skill-building workshops at the Summit focused on social and cultural aspects, which means that these topics are important when supporting the development of global responsibility. *Reflection* and *assessment of previous assumptions* were frequently revealed after students were exposed to new environments, cultures, and daily practices, including but not limited to economic differences, job duties, and traffic patterns. This indicates that the Summit provided opportunities for students to critically reflect on their experiences and positionality. Indeed, we found that these reflections frequently focused on the participants' positionality and role in these contexts (i.e., their privilege). Many students referenced their visits to historical sites and museums, a prerequisite to living in the village, as impactful and confronting, challenging previous assumptions about the history and culture in Cambodia. *New situations,* specifically the homestay experience, were heavily mentioned during final reflections post-Summit, suggesting a lasting impact of this phase of the Summit. Although the immersion of each student varied, as attendance for workshops, friendships within the local community, and homestay differed for each student, all students independently spoke about this phase during the Summit, referencing the 'newness' of the experience. This new situation is the foundation to *assessment of previous assumptions* and *skill-building*, along with other learning outcomes, marking this point as a key inclusion to transformative learning.

5.4 Implications for immersive design programs

Eight phases in Transformative Learning Theory were present in most of the participants' data: *Phase 1: A New Situation, Phase 2: Self-Examination, Self Reflection, Phase 3: Assessment of Assumptions, Phase 4: Recognition of a Shared Transformation, Phase 6: Planning Action Steps, Phase 7: Knowledge and Skill Acquisition, Phase 9: Building Self-Confidence, Phase 10:*

Reintegrating into Life. Many aspects of the Summit's design supported these learning outcomes, with the program intended to influence positive perspective shifts, and an increased understanding of global responsibility. Designing the program to take place in a foreign country, different to applicants' home country, immediately created a new situation for participants. Although the program was developed with a human-centered design process at the forefront, cultural and historical activities were planned in the first week, giving the students context of the region. The first week in Phnom Penh included a trip to S21 Killing Fields and Tuol Sleng Genocide Museum, both historical sites from the recent genocide (1975-1979) that lasted 3 years, 8 months, and 21 days. This visit was described as impactful, important, and confronting by participants, as it showed them a significant part of history of the country that shapes contemporary context. These site visits consistently prompted self-reflection and assessment of assumptions from each participant. Through EWB-run workshops and stakeholder visits, students gained interview skills, a skill that was not presented in any previous learning setting (university, clubs, etc.). Other skills mentioned, such as stakeholder analysis, team communication, and working with interpreters were supported through design process sessions, stakeholder meetings, and related workshops, which required all participants to complete interviews during the second week. The program planned large group and small group debriefs that were held throughout the Summit, aiding students to recognize a shared transformation, build confidence in their learnings, and during the final week, prepare for the perspective shift as participants returned home.

Three phases in Transformative Learning Theory were absent from most of the participants' data: *Phase 5: Options for New Roles*, *Phase 6: Planning Action Steps*, and *Phase 8: Trying New Roles*. Although each participant mentioned skill-building and knowledge learning, only one of the three students described how they plan to apply the new skill. A core element of the program was frequent debriefs where students discussed what they had learned with each other. These debriefs included reflective questions on students' steps going forward. However, without direct prompting in the interviews, action steps were rarely mentioned. This presents an important opportunity for program designers to implement specific recommendations for students to plan action steps to integrate this knowledge into their future. Similarly, this relates to the other two phases not mentioned, options for new roles and trying new roles. After experiencing a new situation and gaining skills, understanding what the next opportunities are to use these skills can be a helpful step and guidance to students integrating into life after an experience with new perspectives.

5.5 Use of Transformative Learning Theory to explore student's experiences

Transformative Learning Theory provided a useful framework for examining how students experienced and interpreted the Summit. By leveraging the theory's ten phases, we were able to identify specific moments, activities, and interactions that aligned with shifts in students'

perspectives on global responsibility (or, at least challenged students to reflect or consider global responsibility differently). Applying this framework across three participants revealed distinct learning trajectories, with different experiences prompting varied forms of reflection and perspective change. This finding underscores the inherently individual nature of immersive global design programs and suggests that students engage with transformative processes in varied and non-linear ways.

In addition to retrospective analysis of student experiences, Transformative Learning Theory offered a lens for identifying where educational interventions may be more intentionally designed to support learning. Mapping students' reflections onto the ten phases areas that were emphasizes and areas that were absent or under-supported in the program.

5.6 Participants' variety in background and motivation

As shown in our findings, each participant had different backgrounds before attending the Summit. While all three participants were engineering students in Australia, they each described different experiences at university, varying upbringings, and a diverse range of experience in humanitarian engineering. Previous studies show that personal background knowledge can influence cross-cultural understanding and learning outcomes [41], [42]. The variety in participants' backgrounds, such as previous travel experience, humanitarian engineering experience, and time spent abroad, illuminated the varying ways participants entered the summit. Similarly to the variety in backgrounds, all three participants described different motivations for their attendance on the trip. Prior research has explored the effect of motivation on transformational learning experience when educating engineering students and indicated that completing an transformative process requires a level of motivation throughout the entire learning experience [43]. As participants explained different reasons for applying, varying from class credit, to a deeper understanding of other cultures, these motivations influenced how they approached the Summit.

We highlight that participants' backgrounds and motivations are highly personalized and variable. Student's background and motivations have been shown to be key predictors in learning outcomes [42]. All of these variables affect initial views on global responsibility, and perceived perspective shifts, influencing program engagement.

6 Future work and limitations

We explored the experiences of three male Australian undergraduate students who participated in an immersive cross-cultural design experience. The findings contribute to a broader effort to support engineering students' development of globally responsible mindsets and values. Several limitations should be acknowledged. First, this study draws on in-depth qualitative data from a

small, purposefully selected subset of participants. Although eight students consented to participate in this study, we selected three students for inclusion in this study based on the richness and completeness of their data. While this approach enabled deep exploration of individual experiences, it may limit the generalizability of the findings. Future work should examine larger and more diverse sets of participants, including women and those from non-English speaking backgrounds, to explore whether similar patterns emerge across students with varying backgrounds, levels of engagement, and prior cross-cultural experiences.

In our work, we applied Transformative Learning Theory as an analytical lens to examine students meaning making and shifts in perspectives. While this theory is well suited for exploring changes in values and worldviews, it places emphasis on conscious reflection and articulated perspective change. This may mean that more subtle, incremental, or tacit learnings were overlooked. Importantly, our analysis is limited to the extent to which participants were willing and able to articulate their experiences and reflections. As with all self-reported and reflective data, students may have struggled to fully express their perspectives, may have emphasized socially desirable responses, or may have omitted experiences they found difficult to articulate. Future studies could address this limitation by incorporating additional data sources or methods for measuring and assessing global responsibility over time.

7 Conclusions

This study examined the experiences of three male undergraduate engineering students participating in an immersive international design program. Analysis revealed that each participant engaged with the experience in distinct ways, entering and progressing through learning phases differently and to varying extents. Participants' reflections and responses to similar events varied considerably, underscoring the highly individualized nature of immersive learning and suggesting that multiple factors influence shifts in students' views and beliefs, such as prior experiences and motivations to participate.

Evaluating immersive educational programs such as the EWB-Australia Design Summit provides important insights into how program elements support students' development of global responsibility and awareness of engineers' societal impact. To more effectively foster these competencies, it is critical to examine program intentions and also how students with diverse backgrounds and perspectives experience and interpret them in practice. This work represents an initial step in understanding how specific program design decisions shape student learning within immersive global programs. Future research will expand this analysis to additional participants and iterations of the Summit to more systematically examine how particular program components contribute to students' learning and perspective development.

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