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# The role of empathic experiences of entrepreneurial engineers within accelerators: a phenomenological study

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**Abstract**—In this full research paper, the empathic experiences of entrepreneurial engineers within accelerators were investigated. Traditionally, engineering research and literature focus more on developing students' technical expertise and knowledge than social skills. However, in recent years, a request for T-shaped engineers with developed social competencies has been formed within the field. One of the essential social competencies in engineering is empathy. Engineering educators have been exploring how to develop this phenomenon using different approaches and interventions such as human-centered design, ethics courses, and service-learning. Another vital component that is being included in the engineering curriculum is an entrepreneurial mindset, where the ability to empathize is also one of the essential competencies. Despite the importance of empathy, existing theories of empathy are ill-suited for entrepreneurial engineering theory. For empathy development among entrepreneurial engineers, it is important to have models of this phenomenon that reflect the contextual features of both entrepreneurship and engineering practices. In this study, the hermeneutic phenomenology is implemented to investigate engineering students' lived empathy experiences and understanding of their interpretations of empathy in an entrepreneurial context. The results of this study can become the foundation for developing contextual models of empathy that reflect the practice of entrepreneurial engineers.

**Keywords**—*engineering education, empathy, entrepreneurship, accelerators*

## I. LITERATURE REVIEW

The complexity of existing global problems shaped the demand for the training of holistic engineers [1]. Considering this need, currently, there is a continuous dialogue in the engineering and educational contexts about the necessity to develop certain skills or competencies to meet the requirements of contemporary engineering practice. Over the past decades, in these discussions, researchers and practitioners have increasingly noted the important role of empathy in engineering [2], [3], [4], [5]. For example, the number of references to empathy in the American Society for Engineering Education's (ASEE) conference proceedings quintupled (from 16 to 72) between 2010 and 2018 [6], [7]. This is due to the increasing popularity of various types of designs, such as empathic or human-centered ones, where empathy plays an important role or might be related to other

empathy-driven processes that are part of engineering practice, such as communication with teammates and mitigating conflicts [8], [9]; ethical decision-making [10], [11]; or caring for stakeholders [12]. Taking into consideration the importance of empathy in engineering practice, researchers and educators have started investigating different educational approaches that can trigger empathy, such as service-learning [15], ethics courses [12], mindfulness training [16] or design projects [17]. Thus, there is growing interest in empathy research.

In parallel with highlighting the importance of certain social skills for engineers, such as empathy, a growing number of professional associations, organizations, and researchers are emphasizing the need to develop entrepreneurial competencies in engineers and to integrate entrepreneurial activities into the engineering curriculum. For example, according to the American Society for Engineering Education (ASEE) [13] "It is the time for engineers to be agile, innovative, entrepreneurial, and opportunistic." The European Society for Engineering Education experts also believe that entrepreneurial skills, creativity, and innovativeness should be widely represented in engineering programs [14]. The Australian Council of Engineering Deans (ACED) [15] adds that engineers of the 21st century should have deep technical and professional expertise and also other essential competencies such as social and communication skills, entrepreneurship, creativity, opportunity recognition and resilience. That is why entrepreneurial skills along with other competencies, will be an important part of engineering practice.

The essential role of entrepreneurial competencies and mindset in engineering practice and the existing demand for holistic engineers with well-developed social and entrepreneurial competencies have led to the formation of 'entrepreneurial engineers' [16], [17]. Within the framework of this concept, it is implied that an engineer should be ready both to create diverse types of businesses and to work in engineering organizations after graduating from an educational institution. That is why Elia, Margherita, Secundo, and Moustaghfir [18] stated that for effective training of entrepreneurial engineers, it is necessary to design new learning models based on entrepreneurial and

engineering experiences considering contextual characteristics of both fields. At the same time, it is also vital to have an understanding of the nature of certain phenomena, such as empathy, considering its role and potential application in certain contexts (engineering and entrepreneurship).

Despite the vital role of empathy in various industries, there are many challenges in studying this phenomenon due to a large number of definitions. The traditional definition of empathy that is commonly used in different disciplines is “putting yourself in the shoes of others” [19], [20]. It is stated that empathy involves both cognitive and affective components, clarifying that in the process of empathy, in addition to different understandings of other perspectives, it is also important to take into account emotions [21], [10]. At the same time, according to Yeaman [22], to create effective teaching practices aimed at developing or triggering empathy, it is essential to have models and definitions of empathy that take into account contextual features. For example, Walther, Miller, and Sochacka [23] proposed a model of empathy in engineering where this phenomenon is conceptualized as a learnable skill, practice orientation, and way of being. In this regard, when creating educational approaches for the development of empathy, it is vital to understand the facets of this phenomenon and the contextual characteristics of practice.

Within the entrepreneurial field, empathy is an essential element of different entrepreneurial processes and one of the determinants in creating startups and various businesses [24], [25]. It is believed that empathy is a vital component of emotional intelligence, and well-developed empathic abilities can help entrepreneurs to strengthen their emotional resilience and cope with various difficulties and uncertainties, as well as effectively interact with different stakeholders [26]. Empathy and the ability to empathize are also necessary elements in various types and models of design that are actively used in engineering and entrepreneurship, such as design thinking [27] or human-centered design [28]. Considering the importance of this phenomenon in entrepreneurship, the development of empathy has become widespread in various entrepreneurial educational approaches and programs. For example, Neck, Green, and Brush [29] declared that educators should pay particular attention to ‘Practice of empathy’ (as well as the other four practices: ‘Practice of play,’ ‘Practice of creation,’ ‘Practice of experimentation’ and ‘Practice of reflection’) when teaching entrepreneurship. However, despite the importance of this phenomenon in entrepreneurial practice, the existing theories of empathy are ill-suited for the entrepreneurship context, as they mostly contextualize it as an emotion-matching process [30].

In this study, the engineering students’ lived experience of empathy in the context of entrepreneurial programs will be explored. This study aims to understand how engineering students interpret the phenomenon of empathy within entrepreneurial programs (experiences), focusing on students’ meaning-making process of their lived experiences. Yeaman [22] stated that ‘there are limited studies in engineering education geared towards understanding empathy development from the descriptions of students themselves.’ This research allows students to contribute to the institutional understanding of the phenomenon of empathy in the entrepreneurship engineering context. This study aims to form an understanding of the phenomenon of empathy in both engineering and entrepreneurial contexts. This understanding

can be used to form educational approaches for developing empathy in engineering entrepreneurs that will help students not only understand the importance of this phenomenon in their professional engineering career, but also to develop empathic skills that can be used in creating diverse types of ventures. The following research question guided this study: **What is the lived experience of engineering students’ empathy in the context of entrepreneurial programs?**

## II. METHODOLOGY

As this study aims to understand how engineering students interpret their empathic experiences within the context of entrepreneurial programs, a hermeneutic phenomenology has been selected as a methodological basis for this research [31]. Presently, research on empathy within engineering entrepreneurship is limited and does not investigate empathy itself. However, the phenomenological inquiry was used to study the experience of empathy in the context of service learning [22], professional formation of engineers [32]

Hermeneutic phenomenology allows researchers to describe the nature of an explored phenomenon within a unique context. Therefore, researchers employ an approach allowing them to theorize lived experiences and understand how participants interpret the role of these experiences in their practice [33]. The authors chose between the two phenomenological approaches before commencing the research: transcendental phenomenology and hermeneutic (or interpretative) phenomenology [31]. Within the transcendental perspective, it is believed that a researcher’s bias can be eliminated while exploring a phenomenon. Therefore, researchers can describe the true nature of a phenomenon based on an unbiased review of the research data. The hermeneutical perspective, on the contrary, rejects a possibility of a bias-free approach and suggests taking advantage of the researcher’s background and knowledge when conducting a study. Furthermore, hermeneutic phenomenology encourages researchers to reflect on their perspectives and experience during data analysis for a deeper understanding of an explored phenomenon [34].

In this regard, given the importance of their own contexts, the authors decided to use the hermeneutic approach when exploring students’ lived experiences. All authors of this paper have a background related to either engineering education or designing and delivering entrepreneurial development programs. Their unique perspectives and experiences enriched the meanings that emerged from the data.

## III. DATA COLLECTION

Research data was collected through semi-structured interviews completed in 2021-2022. Before commencing the interviews, the UTS Research Ethics Team approved the research. Eleven engineering students who had completed entrepreneurial development programs participated in the study. The authors interviewed participants from four Australian university-based accelerators: UTS Techcelerator, Peter Farrell Cup (PFC), Melbourne Accelerator Program (MAP), and Velocity Program. An accelerator is one of the programs aimed at teaching entrepreneurial skills within the entrepreneurship education ecosystem, including university-based ecosystems [35]. Accelerators include both components of an educational process: learning activities and practical experiences that occur between 10 weeks to 5 months. Some accelerators also provide funding schemes for prototype development or as a bonus for the most successful participants

(e.g., each team in UTS Techcelerator received \$10k at the beginning of the program).

All selected programs are university-based accelerators aiming to help participants to develop a working prototype or a minimum valuable product (MVP) through participating in educational activities (e.g., workshops, group meetings, learning circles), mentoring, and working on a real project or a start-up. University-based accelerator programs are examples of entrepreneurial programs focusing on intensive and time-bound support for students when creating start-ups and business ventures [36], [37]. This entrepreneurial program includes educational modules, mentoring support, and entrepreneurial practice when students are encouraged to communicate with potential customers, develop a prototype, and perform market analysis. That is why, by examining students' experiences in university-based accelerators, the empathy interpretations can be explored in educational and entrepreneurial activities. There were two selection criteria: first, participants had to participate in an entrepreneurial university-based accelerator program, and second, they had to study engineering bachelor's or master's programs at a university while participating in one of the chosen accelerators. Considering the narrowness of the cohort, we did not set any quotas based on gender/age/program of study. As a result, we interviewed nine males and two females, and this gender mix occurred naturally. The participants are presented in Table I.

Since entrepreneurial programs list their participants and startups on their official websites, most interviewees were invited to participate through direct emails from an official university email account. Program coordinators or other participants referred some participants. Consent to interview program participants was obtained from program managers and coordinators. Also, each interview participant was provided with the participant information sheet and asked to sign the consent form before the interview. On average, interviews took around 60 minutes. Each interview was audio-recorded and then transcribed for further analysis.

TABLE I. PARTICIPANTS

<i>Gender</i>	<i>Degree</i>	<i>Startup type</i>
Male	Bachelor of electrical Engineering (Honours); Bachelor of Science Advanced	Business sales platform
Male	Bachelor of Computer Science, Data Science	Drugs management platform
Male	Bachelor of Science, Mechanical Engineering; Master of Engineering (Mechatronics, Robotics, Automation Engineering)	Platform for automatic quotation
Female	Bachelor of Computer Science (Honours), Computer Software Engineering	Dating app
Female	Bachelor in Software Engineering	App to post items on multiple marketplaces
Male	Bachelor of Engineering (Honours)/Bachelor of Science (Computer Science)	Soda vending machine
Male	Bachelor of Engineering, Computer Science	Airport information app
Male	Bachelor of Engineering and Commerce, Electrical Engineering	home bushfire sprinkler system

<i>Gender</i>	<i>Degree</i>	<i>Startup type</i>
Male	Bachelor in Mechanical Engineering & Industrial Design	IP licensing platform
Male	Bachelor in Computer Science	Contracting app for businesses
Male	Bachelor of Technology (Mechanical Engineering); Master's degree (Data Science)	Supply chain app for small businesses

As this research focused on the lived experiences of engineering students' empathy in the context of entrepreneurial programs, we asked questions about their understandings and experiences of empathy. The interview guide was designed to extract the participants' empathy experience and sense-making process. Here are some of the examples of questions that guided the interviews:

1. What does empathy mean to you? How would you define empathy?
2. Tell me what empathic experiences (if any) you think may exist in an accelerator?
3. If someone asks you what is going on in your mind when you empathize with others, what would you say?

#### IV. DATA ANALYSIS

A hermeneutic phenomenology does not have a predefined data analysis method [38]. Therefore, researchers must select a suitable analytical approach based on their research aim and questions. As current research aims to explore participants' interpretations of their empathy in their experiences within entrepreneurial programs, the authors chose the Interpretative Phenomenological Analysis (IPA) as an analytical tool presented in Table II. The IPA implies reading and re-reading the research data, forming preliminary themes, reflecting on them, and further elaborating, as well as looking for patterns across cases (in this research, cases refer to interviews) [39].

TABLE II. INTERPRETATIVE PHENOMENOLOGICAL ANALYSIS

<i>IPA steps</i>	<i>Tasks</i>
Step 1: read and re-read transcripts	Organising the dataset into texts; Iterative reading of texts; Preliminary interpretation of texts.
Step 2: Make initial notes	First order constructs; Data coding.
Step 3: Develop emerging themes	Grouping constructs into themes; Reflection on emerging themes.
Step 4: Search for connection across themes	Further elaboration of themes; Repeating the hermeneutic cycles.
Step 5: Move to the next case	Distinguish the nuances and uniqueness of the data lodgers.
Step 6: Look for patterns across cases	Comparing themes across sub-discipline groups

#### V. RESULTS

The participants were encouraged to share their interpretations of their empathic experiences while participating in an accelerator program. As participants collaborated actively with others during programs, the interviewer asked them about their interactions with peers and teammates, mentors, potential customers where applicable,

and other stakeholders. After the implementation of the IPA, five themes emerged as described in Table III.

TABLE III. THEMES AND SUB-THEMES

Themes	Sub-themes
Understanding others	Identifying existing problems/needs Identifying user requirements Understanding people' emotional state Simulating experiences of others
Simulating (imagining) potential experience constructed by other people	Simulating others' experiences to understand people' potential needs and problems Simulating others' experiences to prepare for contingencies
Switching types of thinking	understanding differences between customer and business priorities switching from zoom in to zoom out levels considering both cognitive and affective domains
Being open-minded	Being open to feedback Coming to new ways of knowing Learning the value of letting go some ideas
Acting responsibly	Reviewing ideas through ethical and sustainability lenses Considering all types of stakeholders

The first theme, understanding others, is formed by four sub-themes. The first sub-theme arose as participants described their empathic experiences as essential for helping them in **identifying existing problems/needs** (Participant 5: *“what are the pain points that they (customers) are facing, and how my product actually solves those pain points, that requires a huge amount of empathy for the user”*) or **user requirements** (Participant 3: *“when conducting empathic interviews, we need to identify as many requirements as possible such as their preferences regarding the color or icons”*). Also, talking about the role of empathy in their practice, participants focused on **emotions of other people** (Participant 8: *“so what is going on in my mind when I empathize with others? I literally imagine I am that person, and what feelings would I feel if I were that person”*). Furthermore, apart from understanding the current state of others through identifying the needs, requirements and emotions of others, participants stated they had used their empathy to **simulate the experiences of others** (Participant 6: *“it is best to understand how they are using it. the only way I could do that is by empathizing and trying to understand and simulate their perspective”*).

Apart from understanding the current state of others, empathy plays a key role in simulating a potential future constructed by other people. First, it can relate to **simulating others' experiences to understand people's potential problems and needs** and empathizing to predict future patterns (Participant 7: *“you just ask yourself what people would do in this and future situation to understand their needs”*). Another interpretation that emerged from the data was **simulating others' experiences to prepare for contingencies** (Participant 6: *“sometimes things change fast like we might have a new competitor on the market, and now we need to think about what they're doing and will be doing and what we can do to differentiate ourselves”*). These interpretations align with other theories, describing empathy as a fundamental component of the opportunity recognition stage of an entrepreneurial process [40].

The third identified theme covers switching types of thinking as one of the interpretations of empathic experiences.

Firstly, while empathizing, participants attempted to **understand the differences between customer and business priorities**, balancing the business benefits and interests of their customers (Participant 10: *“it is important for us to understand that they have other things to do, and we cannot just jump on the phone with them and waffle for two hours.... I think that in terms of respecting others, it is important for us to go into our interactions with a really clear idea of what we need and what we can provide and do not waste people's time”*). **Switching from zoom in to zoom out levels** is another sub-theme that can also be explained as changing focus from the needs of an individual to market trends (Participant 7: *“I empathize with them, and I try to give everyone my time and understand what he or she wants...at the same time we need to remember that there are broader market trends and we need to be able to consider both of those domains”*). Finally, it is the ability to **consider both cognitive and affective domains** while empathizing with others (customers, stakeholders) (Participant 10: *“it is like the first stage of the engineering processes to elicit customer needs and wants. And then once you have a first product down, then you can revisit the customers and reuse empathy again with this prototype product and see if that has changed the feelings that you feel and if it has, then you are probably on the right path. If not, then you can readjust the technical work so yes, I think you can definitely use empathy”*).

The fourth theme that emerged from participants' interpretations of the role of their empathic experiences is being open-minded, including accepting feedback and new ways of knowing, as well as the ability to stop considering some ideas. **Being open to feedback** has been described by students as considering other perspectives about their ideas, which in some cases led to positive outcomes for their project (Participant 5: *“I guess being really open to constructive feedback, but also discussing afterwards to see if this feedback is really constructive and actionable and how we can use that to make us better. They think our product is bad...If we were to start taking an approach of being more hard-headed and prideful like, we were just protecting our idea, which would lead to heaps more conflict... It is always important to listen to other people's opinions”*). While feedback was described in the context of discussions with current or potential customers, the second sub-theme, **coming to new ways of knowing**, emerged from discussing interactions with peers and mentors (Participant 2: *“sometimes when I design something through within my team, a set of members may not approve it or not like to the features of it and it sometimes may result in a debate of sorts and the way that I worked around this was not by being rigid and inflexible, but by being flexible and understanding of my team members' perspective and opinions of it. In doing so, not try to change their opinion, but try to understand where they are coming from and see things from their perspective”*). However, being open to different opinions and views means taking new perspectives on board and also **letting some ideas go** (Participant 6: *“I think it was during one of the monthly catch ups with a mentor where our team really realized that the direction, we were taking was a bit unfeasible and that we needed to keep it. I think doing that pivot for the first time really taught me how to navigate the change and the ambiguity and challenged me to quickly learn about these and challenged myself to apply it at the same time”*).

The fifth theme relates to ethical behavior or acting responsibly towards clients, business partners and

stakeholders, the environment, and the community. Participants **reviewed ideas and decisions through ethical and sustainability lenses** (Participant 9: “*after doing the Accelerator I knew it is probably the most important thing (Their perspective). You can build the thing right. But have you built the right thing? So, like the engineering side is looking at building the thing right and getting all the text down, but if that thing is not the right thing for the person, then like what's the point, it's just a wasted amount of energy and resources*”) and **considered all types of stakeholders and customers (including marginalized groups)** (Participant 6: “*we want to make our product usable for all people. I could not design a product for color impaired individuals, because I do not understand, I do not know more about how their impairment affects the usage of certain things. So, the only way I could do that is by empathizing and trying to understand their perspective, but also connecting with them and speaking with them to hear about their experiences and what that means for them in certain different contexts*”).

## VI. DISCUSSION

This study demonstrates how engineering students from the chosen accelerator programs interpret the phenomenon of empathy as an ability to adopt the perspectives of others, considering both affective and cognitive domains. Numerous studies of the empathy phenomenon describe this process as “perspective-taking” [41]. According to Hess, Strobel, and Brightman [42], empathic perspective-taking is an important element of engineering practice, as it helps engineers consider various stakeholders' opinions when making decisions. At the same time, understanding customers and a target audience with a focus on understanding their behavioral patterns, experiences, and characteristics are one of the key elements of entrepreneurship [43]. As part of entrepreneurial programs (accelerators), engineering students learn various tools, such as customer journey or empathy maps, that allow them to understand the existing characteristics and experiences of their clients, which in turn helps them understand the existing (current) reality and trends constructed by other people.

At the same time, this study shows that interviewed engineering students interpret empathy not only as taking the perspective of others to understand current experiences, feelings, and characteristics but also as a simulation of future (potential) experiences or feelings. According to [44], entrepreneurship can be defined as the active management of the image of the future and innovation. Also, when creating products and businesses, it is important to have an understanding of long-term trends to minimize potential risks and help a business to survive. In this regard, it can be noted that the engineering and entrepreneurial practice, as well as educational activities within entrepreneurial programs, sustain conditions for the formation of empathy interpretations as a phenomenon for understanding both current characteristics and experiences and potential and future ones.

In both entrepreneurship and engineering contexts, it is essential to be open to new experiences for a holistic understanding of a business and customers that can be obtained through a range of sources. According to [45], social networks have a considerable influence on entrepreneurial activity. Entrepreneurs consider these networks a valuable resource that can provide advice, emotional support, and financial capital [46]. One of the goals of entrepreneurial accelerators is to create these social networks through collaborative learning and networking. In these programs,

different activities are aimed at stimulating participants' interactions, for instance, learning circles or demo nights. At the same time, it is believed that social and empathic skills can help in obtaining new knowledge or effective feedback. According to Kokkonen and Koponen [47], to network effectively, it is important to use various techniques (e.g., active listening) that allow participants to understand the position of others and stimulate them to be open to new ideas and advice. Then, after receiving feedback or new knowledge, it is important for an entrepreneur to understand constantly changing lenses/modes, how that information relates to the business or market context, as well as whether this insight is located in the technical or emotional dimension. Also, some accelerators (UTS Techcelerator, PFC) included a training component with a design thinking model that requires students to switch types of thinking in order to create human-oriented products. Therefore, the culture of entrepreneurship and the structure of accelerator programs may create prerequisites for the formation of empathy interpretations as an “openness to different opinions and views” or “switching modes.”

Finally, within the framework of the analyzed accelerators, engineering students should think about the ethical component when producing ideas and creating products. For example, in some programs (UTS Techcelerator), students had to obtain ethical approval when creating a product, while others encouraged participants to create startups that make a social impact (MAP, Velocity Program). At the same time, as part of the entrepreneurship practice, it is important to conduct a detailed analysis of the target audience and stakeholders, which encourages taking into account the interests of different groups of people. In this regard, these processes and goals can encourage engineering students to take into account the ethical side when forming an understanding of the phenomenon of empathy.

## VII. RESEARCH LIMITATIONS AND RECOMMENDATIONS FOR FUTURE RESEARCH

This paper explores interpretations of engineering students who participated in entrepreneurial programs of their empathetic lived experiences. According to Skjaerven, Kristoffersen, and Gard [48] the aim of the phenomenological study is to generate detailed descriptions of the phenomenon. However, when creating models of the phenomenon, it is also important to have other types of evidence that support the facets and role of empathy in certain experiences. Future research can focus on behavioral indicators implied to empathy using other methodologies such as ethnography and case studies. Also, in this study, accelerators were considered examples of entrepreneurial programs, while there are many other entrepreneurial educational approaches and programs such as incubators, courses, or subjects. Therefore, for a holistic understanding of the role and phenomenon of empathy, future researchers can investigate empathy in these contexts.

## VIII. PRACTICAL IMPLICATIONS

One of the primary aims of this study was to investigate the phenomenon of empathy in entrepreneurial and engineering contexts in order to encourage the creation of empathy development models and exploration of educational activities that can prepare holistic entrepreneurial engineers. This study demonstrates that students in our sample interpreted empathy as an essential component of engineering and entrepreneurial practices. Hence, specific capabilities

such as openness to different opinions and the ability to consider affective and cognitive as well as various thinking styles are important. In this regard, when designing educational programs and activities, it is essential to equip students with tools and techniques that can help them understand the perspectives of individuals (customers, mentors, investors, teammates, etc.) and the context from different perspectives such as customer journey map or empathic interviews which are one-on-one conversations focused on extracting customers' problems and experiences [49]. Moreover, preliminary activities should be implemented to develop specific skills that can help them use these tools, such as active listening, reflection, or creating mental models of the experience of others (imagining).

This study suggested that when describing empathy, students focus on analyzing the present situation (customer needs, experiences, contextual characteristics) and interpreting empathy as a phenomenon that can help minimize future risks and predict the future behavior of others. It is important to consider the history (background) of the formation of specific trends to imagine (simulate) potential experiences and pay attention to triggers and trends. In this regard, when designing and implementing future educational models and activities, educators may encourage students to focus on the characteristics and perspectives of people and take into account the contextual attributes.

In addition, an important finding of this study was an understanding that empathy refers to acting ethically. One of the dominant roles of the ethics process in engineering is avoiding harming other people. When conducting research involving other people, engineering students must obtain approval from the university's ethical committee, where they must provide evidence that their research will not harm participants or put them at risk. However, when engineering students participate in entrepreneurial programs and try to create products or start-ups, they also focus on different target audiences and stakeholders to create a profitable business. At the same time, it should also be taken into account that nowadays, it is increasingly possible to trace the motivation of entrepreneurs to create a business as a desire to improve people's lives. In turn, this creates a certain community and an environment that allows learning. Therefore, when creating educational activities, it is important to encourage students to share their motivation and to support students' focus on wider target audiences in order to form a culture of 'social impact' in the classroom.

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