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HOW DO TEACHERS RESPOND TO SUSTAINED CHANGE?

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ABSTRACT

Higher Education is facing profound shifts. Employers seek graduates who can work effectively with others in rapidly changing contexts, defined by globalisation, diversity, digitalisation, climate change, complexity, a European war, and a recent global pandemic. The latter caused an instantaneous switch to online learning, where academics were forced to conduct their normally face to face classes through video conferencing tools. The calls for sustained change are challenging academics to rethink their traditional teaching roles and to develop new understandings of future-oriented learning methods and goals for their students.

This paper describes the research we have conducted into how academics have responded to these challenges, both short term (emergency remote teaching) and the long-term shift to new ways of teaching (e.g., for transdisciplinary learning working with diverse communities on their solutions). The authors have explored this issue over the last two years, using qualitative research methods, through workshops and interviews, which have been analysed for major themes.

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1 INTRODUCTION

1.1 Purpose

The purpose of this project was to hear a range of teacher voices, to understand the ways in which they are adapting to a rapidly changing world and how they are preparing students to work in this age of complexity. The project explored teaching insights and experiences during the COVID pandemic, as an example of future higher education challenges, to gain insights into the future directions of engineering education. Findings from this project can inform professional learning programs for academics at universities, to advance curriculum and teaching methods.

1.2 Purpose and Research Question

Our initial research focus was to explore how to develop the Deliberate Teacher's Voice in the Age of Complexity, Sustainability, Globalisation, Digitalisation and Transdisciplinarity. With deliberate we mean purposeful and with voice we mean a values-based identity [1]. To explore this idea, we needed to examine academic teachers' struggles and successes in finding their professional voice and why is this important now. The project was guided by three interrelated sub-questions:

1. What impact has COVID made to teaching perspectives of academics?
2. What are the big challenges in preparing graduates for their futures?
3. How is academic teaching adapting to these big challenges?

2 LITERATURE REVIEW

In 2019, when this project started, the Australian Council of Engineering Deans (ACED) was midway through a formal review of engineering education. The preliminary report highlighted the need for graduates to have a greater awareness of the social dimension of engineering, among other recommendations [2]. The final ACED report from 2021 [3] further recommended better **integrated curricula** (focused on development of professional skills), collaborative and open-ended problem-finding and solving in multidisciplinary project teams, greater emphasis on **digital design tools,** and stronger **industry** and **community** links in teaching.

There is also a long history of reviews of engineering education that have pointed towards the need for a broader skill set, greater awareness of the social context of engineering, more industry engagement, and more project-based learning [4-9]. Many papers have also explored the effects of emergency remote teaching imposed by the COVID pandemic, e.g., [10-12]. We incorporated this disruption into our study to see how the changes that COVID had forced on us might have opened academic minds to new ways of thinking about their teaching and the other big changes happening in the world, particularly climate change and the need for sustainability.

3 METHODOLOGY

3.1 Research Approach

To answer the research questions, a qualitative research paradigm was chosen as appropriate methodology; more specifically we adopted a philosophical hermeneutics approach [13], which blends phenomenological lived experiences and

memorable moments with philosophical hermeneutics, a shared interpretation of perceptions. Philosophical hermeneutics contends that subjective experiences and perceptions need to be interpreted from different perspectives and not only from within the participant's assumptions, context, and background. A key feature of this approach is its question and answer dialogue between researcher and research participant, among the researcher team and with the literature [14]. The research was explorative seeking deeper and critical understanding of good teaching practices; it did not aim to be representational.

3.2 Research Design

The research design consisted of two phases. In phase 1, we conducted focus groups with European participants at the SEFI 2021 conference and Australasian participants at the AAEE 2021 conference (AAEE is the Australasian Association for Engineering Education). Because of COVID, we used zoom and breakout rooms. All three researchers were present and made field notes. In phase 2, we conducted semi-structured interviews with teaching academics at TU Berlin and UTS Sydney.

All interviews were recorded and transcribed. Six interviews were conducted face-to-face and three were conducted via zoom for convenience of the participants. Interviews were conducted with two or all three researchers, taking turns asking questions and writing fieldnotes.

3.3 Recruitment

For phase 1 we recruited conference participants via workshop abstracts that declared the research intent and our ethical conduct as approved by the Human Ethics Committee of UTS No. IML202103. 14 and 12 participants were recruited from the SEFI and AAEE conferences respectively.

For phase 2 we recruited nine consenting participants, five from TU Berlin and four from UTS via written invitations using relevant digital communication channels, for example in Teaching and Learning announcements, newsletters, and research networks. The research team was in no direct power relationship with participants. Table 1 (next page) provides brief demographic information of the research participants. For anonymity reasons, only broad demographic categories are provided.

The participants of the focus groups and the interviews covered a wide range of international, cultural, gender, and disciplinary backgrounds. We are aware that the answers and experiences are influenced and shaped by these various perspectives.

3.4 Data Collection

In phase 1 we described the current landscape of engineering education and then invited participants in small groups to respond to three questions:

1. In your opinion: which are the most crucial positive and negative changes in **your teaching** due to COVID?
2. What do you see as the future **big challenges your graduates** are facing?
3. What formats, topics and methods of **continuing education** would prepare you to become a **future-focused** academic teacher?

In phase 2 we collected teaching stories from interviewees using a semi-structured,

in-depth dialogical approach following the hermeneutic tradition [14]. The intent of the interviews was to “gather manifestations of existing understandings” [14]. After piloting 19 questions we reduced them to six key questions to guide the conversation:

1. Tell us about your proudest moment as a teacher!
2. What matters to you as a teacher?
3. What are future trends or biggest ideas in your field?
4. What skills and competences will students need?
5. What does this mean for the teaching required into the future?
6. How do you create collaborative and inclusive classroom environments?

Table 1: Demographics of Phase 2 Participants

Number	Gender	Academic Rank	Institution
1	Female	Professor	TU Berlin
2	Female	Post-doc	TU Berlin
3	Male	Senior lecturer	TU Berlin
4	Male	Assistant Professor	TU Berlin
5	Female	Doctoral student/teaching assistant	TU Berlin
6	Male	Lecturer	UTS
7	Female	Associate Professor	UTS
8	Male	Associate Professor	UTS
9	Male	Associate Professor	UTS

4 WORKSHOP RESULTS

4.1 SEFI workshop (September 2021)

What were some of the positive and negative changes due to Covid?

Issues raised included a sense of urgency to adapt to a new online learning environment, despite sometimes little formal support from the university. There was a clear difference between those who are good at adapting and experimenting with different approaches and those who are reluctant to change. Teachers became overworked and tired, longing to go back to more personal interaction. Similarly, the social wellbeing of students came to the forefront, with more care and consideration required. This point also emerged in our later interviews.

What are the big challenges facing your graduates (beyond COVID)?

Participants mentioned lifelong learning, the need for more hands-on experiences, a greater emphasis on personal development, and limited transferable skills to new situations. This part of the conversation failed to engage with bigger issues such as climate change or complexity. COVID was simply all-consuming at this stage (2021).

What formats, topics and methods of continuing education would prepare you to become a future-focused academic teacher?

The discussion emphasised the need for course team approaches to management and structural barriers, including peer to peer learning, creating space to tell stories, to interact and to share experiences, learning in hybrid systems, working in teams, and experimenting together, and rethinking the conditions within which we must work

as teachers, by setting up the right incentives.

Nevertheless, emphasis on more PBL has “helped to get teachers working more together”. Other suggestions included time for reflection and improved workload models.

4.2 AAEE workshop (December 2021)

Positive changes due to COVID?

There was a surprisingly quick move to online, which, before, most would have said was impossible. Industry-based projects worked well online because many of the industry partners were already remote (in Western Australia). Suddenly students realised they need to be able to work this way. Subjects had to be made more interesting and creative to maintain engagement by the students. The online environment also became quite personal – interruptions from children, etc – which added some light relief to teaching in the COVID era.

Negative changes due to COVID

Participants reported that online is just not the same and particularly hard on first year students. Engaging with each other online was more difficult with a loss of sense of community. The hybrid model (remote + face-to-face) was even very difficult; it was hard to pay attention to either the face-to-face group or the online group.

It was difficult for academic staff to create so much change in such a short time, particularly those who were not skilled in online tools. There was a lack of feedback from students (who often kept their cameras off), and a serious lack of hands-on experiences, particularly laboratories.

Changes for Students

Participants reported that there were many changes for students as well as for academics, e.g., students needed to find information for themselves, which changed the way they taught. Students were forced to adapt to change – some students have been in the same school since kindergarten – they need to learn how to learn and not just be taught. Students needed to develop the confidence to speak up in large online classes.

5 INTERVIEW RESULTS – THE BIG IDEAS

Five interviews were conducted at TU Berlin in June 2022 and four more were conducted at UTS in November/December 2022. Each interview lasted about an hour. The interviews were automatically transcribed using MS Word, with manual corrections. Each of the authors then read each of the transcripts, highlighting themes and quotations. Through our discursive process [13] we identified the following key themes:

1. Engineering as a social practice
2. Collaborative and interdisciplinary learning
3. Students as citizens
4. Student competencies
5. Academic teachers’ perspectives

5.1 Engineering as social practice

Engineering has social consequences; engineering and society co-create each other. Engineering lies at the intersection of the social sciences (human needs), technology design. Gender diversity is also a serious issue, because women have been poorly represented in engineering workforces, at least in Anglophone countries.

For engineers to solve social problems in context, programs need to be interdisciplinary and focus on social justice issues. Engineers deal with interdisciplinary problems in the world – literally between the disciplines. Interdisciplinarity and entrepreneurship are critical skills for the future, as problems become more complex and more interconnected.

> *"I'm particularly interested in the notion of justice-oriented citizenship. How young people grow up to be advocates for systemic change and the kinds of learning experiences that encourage the development of those" (Interview 1)*

5.2 Collaborative and interdisciplinary learning

If we are to develop student engineers with greater social awareness, we need to emphasise learning as a social process. A key shift in new learning environments is from listening to experts to encouraging students to speak up, to find their voice:

> *"[we] immediately start students talking (not listening) - finding their voice" (Interview 4)*

Recognising the messy social context in engineering can be confronting:

> *"This is like one of the … things that they write in the midterm reflection is there's so many new perspectives that I haven't seen and heard and even considered because what we arrange in our teaching is that they meet as equal and then they see that they are not equal in every respect." (Interview 4)*

Once students tune in to the social dimension of engineering, and learning in general, they see the importance of teamwork and collaboration:

> *"Learning design is fundamentally about relationships and those human centred skills of talking and understanding and communication; learning is and always will be a socially engaged endeavour." (Interview 5)*

This new style of classroom can be challenging for academics who see themselves as the expert:

> *"teachers need to be able to orchestrate the class and stop wanting to give the answers" (Interview 6)*

… and for students who bring a traditional learning approach from high school:

> *"[it's] best when students stop worrying about marks and focus on job outcomes" (Interview 9)*

Students need real projects, case-based learning, and discussion, to understand how to work in interdisciplinary teams. They need research-oriented teaching methods – asking questions and questioning assumptions.

COVID has boosted online education in a way we never anticipated. Students have discovered the flexibility that technology provides, particularly for senior students who are often juggling jobs and study (and sometimes families) as they finish their degrees. Students are shifting to online learning and skipping the face-to-face classes to suit their life commitments.

We are seeing greater use of technology to enhance collaboration, a key skill already identified. We are now all experts at online collaboration, helped by the maturing of multipurpose tools (e.g., MS Teams) in the last 3-4 years, supporting video and audio meetings, online forums, file sharing, project teams, plus a plethora of add-ins to support many other functions for team collaboration.

There was some scepticism of these technology trends. Nevertheless, AI is seen as a potential gamechanger:

> *"I think artificial intelligence is going to be significant, especially, but not limited to assessment." (Interview 9)*

… and education is becoming fragmented into smaller pieces (microcredentials), particularly in the postgraduate space:

> *"I think increasingly fragmented educational offerings are going to become the norm. I think learning will become more meaningful and more personalized." (Interview 6)*

5.3 Students as citizens

Interviewee 4 succinctly summed up this theme of students as citizens:

> *"[We are] developing students' critical thinking skills and their ability to think for themselves – communicate, communicate, communicate – that people can speak up for themselves and question their surroundings, that people start advocating for themselves and for others, and sustainability, and we want to produce democrats!" (Interview 4)*

The COVID crisis also helped academics recognise the need to care for students:

> *"Students learn in many ways; We need to care for our students … and for society; trust, flexibility, humour, responsibility … and humility." (Interview 1)*

We need to value the students and to help them to learn to transfer knowledge to new contexts:

> *"Empower your students; each of them is different, with different needs." (Interview 7)*

We also need to help students to take initiative and become confident thinkers and actors in the world (extending the social dimension already discussed):

> *"I want to see that they are able to take initiative to think about it by themselves, like what went wrong and what can I do?" (Interview 2)*

To do this, we need to create inclusive and enabling environments in our classrooms:

> *"I think the way to support that (critical thinking + communication) is through the environment of the course and through the space you provide, because in the end, it's important that everyone feels legitimated to speak and to speak up and to communicate." (Interview 2)*

5.4 Student competencies

Students need competencies in self-management, deep communication skills, through a shift towards independent learning (flipped classroom, online, potential impact of AI), all accelerated by COVID.

> *"[the] best students are quick thinkers, and they have outstanding communication skills. [They can] give good arguments to support their position; they are good team players." (Interview 3)*

We want curious and respectful students who engage in sustainability:

> *“questioning is an important skill - how to question things and cope with not having answers - example of 'blue engineering'; Students need to be curious. We need to emphasise process skills, less about content” (Interview 5)*

Students need new skills in areas such as data literacy. They need to know where to find information. They need to know the changes and dangers of new technologies.

Students need to be supported in the process of developing self-learning competence for lifelong learning as well as transferring previous knowledge and skills to new problems, tasks, and environments.

5.5 Academic teachers’ perspectives

During COVID, the important goal of online teaching changed the role for academic teachers, focusing on facilitating learning:

> *“I think they know more than we know that they know. They learn from youth. They learn in other ways than we think they learn. They learn from you too. They learn from peers. They have different ways of learning. (Interview 1)*

In general, for teachers in engineering education to “teach the goals of projects and ask questions” is crucial as it encourages students to ask questions, use their own words, and work practically. Participants discussed a scaffolded approach to student learning:

> *“What have we learned now? And what can we do with it? And what can't we do with it? Ask questions about potential dangers of a technique we know the students know beforehand. [so that] they are not too surprised, or confronted” (Interview 3)*

Participants discussed their role as a facilitator of learning, and reducing power relations:

> *“One of the core questions in my teaching is power. What are the power relations … talk to someone else and immediately [they] started talking with other people because they were not there to listen only, but to speak with others … about many things.” (Interview 4)*

Sensitivity and awareness for teachers is expressed through the learning environments they create:

> *“I think the way to support that is through the environment of the course and through the space you provide, because in the end, it's important that everyone feels legitimated to speak and to speak up and to communicate” (Interview 5)*

A new approach to **future challenges** in engineering education would be creating conditions for slow understanding of problems. Attenuating learning different technologies, and amplifying the ability to understand concepts behind principles and theories, and develop a prototype around these concepts:

> *“I think the competency development is most important. For me, I get very excited when I see … creative projects where a student has shown that they not only understand the standard methods for completing particular tasks but can actually … reinterpret the media and the methods that are described in new and interesting ways and show that mastery of those techniques. (Interview 9)*

A general approach to **future** engineering education is to go beyond producing materials and expanding students’ knowledge:

"The most important thing is attitude to learn. So basically … I say ASK: A for attitude, S for skill, K for knowledge. So even if you don't have sufficient knowledge, you can acquire the knowledge through the skills. But then most important is the attitude. If you don't have attitude, then the skills and knowledge are useless." (Interview 8)

As a general perspective on aspects of learning independent of changing challenges and learning environments, *"learning is and always will be a social engagement" (Interview 6),* e.g., feedback, learning together all over the world in real time or simulation with AI:

"A lot of them go out and find other sources to check or to read against, or to investigate and I like that it shows broader interest than just showing up, so I guess, summing it all up, it's not about just showing up anymore, because you don't have to show up. It's about, you've actually got to do the learning." (Interview 9)

6 DISCUSSION AND CONCLUSION

In many ways, our observations are unsurprising. There was a clear message that engineering is a social practice and students need to understand the **social context of engineering**, through issues such as sustainability, climate change, globalisation, and so on. What was gratifying was the strength of convictions of some of our interviewees who saw this as both a professional mandate, an essential aspect of democratic citizenry, and a key role for themselves as educators.

An important outcome from COVID was the need to **care for students**, as well as to care for ourselves as academic teachers. This was an extension of the overall desire to educate excellent young professionals, with the confidence to speak up and to make positive change in the world.

Key **student competencies** were identified, particularly communication (including listening), teamwork, critical thinking, student confidence, and lifelong learning. Similarly, **academic competencies** were identified, e.g., the need to 'orchestrate' the classroom – be the conductor, not the instrumentalist. A future task is to take a closer look at the details of these different competencies, for teachers and learners, to confirm and to develop corresponding continuing education measures to support future-focused teaching and learning methods.

As we were analysing our interviews, a new disruption appeared on the horizon of teaching and learning environments with the free release of ChatGPT and other **generative artificial intelligence tools**. By some this is seen as changing the role of the academic teacher profoundly [15] raising questions about what needs to be taught and with what approach, affirming our project and findings. What it means to be human is at the centre of teaching and learning and of engineering.

Our findings reinforce the many **calls to action**, mentioned earlier, to transform engineering education to focus on the social context of engineering and student competency development, supported by new academic competencies for these new learning environments. Transforming how we see our students, and taking care of them and their career development, can change the nature of our curricula, as demonstrated by the examples in Lindsay, et al, [16].

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