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Partnerships in an industrial design studio: augmenting the master-apprentice model to inspire collaboration

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Abstract: The industrial design studio presents opportunities for students to learn a range of skills and knowledge that will equip them to enter professional practice. This paper presents the unfolding of a capstone studio where student teams undertake project-based learning, and where the instructor is both the master and a team-player. The question that is investigated is to what extent does an augmented master-apprentice teaching model impact student collaboration in the design studio, and can the model be used to drive positive learning outcomes. The study considers the design process of 14 student-teams studying industrial design at Western Sydney University (WSU) Australia, and the design process of an instructor-team comprised of four industrial design academics. The paper is an experiential account of a lighting project as undertaken by instructors and students and proposes a novel method for teaching professional practice through co-creation, collective cohesion and by behaviour-modelling of collaboration in action.

Keywords: collaboration; co-creation; industrial design pedagogy; master-apprentice

1. Introduction

This paper investigates if a modification in teaching methods, that is, the modelling of collaborative behaviour through a *community of practice* (the design studio) facilitates an understanding of professional practice in student participants. Professional practice in this case, is resolution of a project brief. There are several key questions to be addressed, namely what is the master-apprentice model used in teaching design process at WSU, and how is it augmented in the capstone studio? Further to this, there is a need to explore what is meant by *collaboration* in the design studio, and why is it important to offer students the opportunity to collaborate. Finally, the paper indicates how the enhanced master-apprentice model impacts the ability for students to produce successful design outcomes.

Definitions for the terms used in this paper are provided so that the authors' intentions are clear. The vocabulary used in describing these activities is important and should be used regularly with students so that the language of communal design is learnt, adopted and reinforced.

The term *co-creation* in this paper assumes the definition as described by Sanders and Stappers (2008) to describe any act of collective creativity, that is, creativity that is shared by two or more people (Sanders & Stappers, 2008 in Kvellestad, 2018). Sanders and Stappers explain that it is an instance of co-creation as it encapsulates many activities that are broadly used in design processes (Sanders & Stappers, 2008).

The term *collaborative learning* is defined by Emam, Taha and ElSayad (2019) as a teaching strategy that is applied with small teams of students of different levels of ability, and where all team members participate to deliver the assigned task (Emam et al., 2019, p. 164). This explanation of the concept applies well to the studio context explored in this paper as it supports the goal to facilitate student-centred learning, also established by Mattessich, Murray-Close, and Monsey (Mattessich et al., 2001 in Emam et al., 2019, p.164).

Cooperative design, participatory design and collective creativity have similar meaning in describing the activities undertaken in the capstone studio. Sanders and Stappers (2008, p.6) explain that these terms are interchangeable, and that participatory design has a long history as it has been commonly referred to as *collective creativity*. Sanders and Stappers cite Bodker (1996), asserting that there is evidence of the activity taking place in the 1970s in Norway, Sweden, and Denmark as part of the Collective Resource Approach, where workers developed workplace systems to improve productivity (Bodker, 1996 in Sanders & Stappers, 2008, p. 7).

Finally, to define *capstones* we will use the definition as presented by Lee and Loton (2015) in the *Office of Learning and Teaching's 2015 Report* on capstone curriculum design. The report refers to capstones as "substantial culminating learning experiences that take place in the final stage of an educational course, offering closure and a focus for the sense of achievement that comes with completion. From a quality assurance point of view, capstones can also provide a means of demonstrating course-level learning outcomes" (Krause et al., 2014; Rasul et al., 2009 in Lee & Loton, 2015).

This paper presents an overview of how the teaching method in the capstone studio endeavours to achieve the terms thus defined and within a *community of practice* (the design studio). Evaluations provided by students involved in the subject and product outcomes are used to show the value of the teaching model. The authors furthermore discuss ways to augment the master-apprentice teaching model in order to enhance the student experience in future iterations of the capstone design studio.

2. Background to the study

The motivation for this study stems from observations and outcomes of industrial design students progressing from their third to final fourth year of an undergraduate degree. Instructors in the program observed that students had a lack of understanding of *how to collaborate effectively* despite having group activities during their studies suggesting studio vocabularies are not standardised to promote recall and subsequent integration. This was exhibited by students that were not proactive in seeking advice on their projects, worked in isolation, and did not offer critique or guidance to their peers. Often, academic feedback was ignored, and it was thus considered that students may not have an adequate understanding of how collaboration should take place, what the benefits of collaboration could be, or how to adequately respond to input from stakeholders. There may be many reasons for the lack of engagement, however it was considered unviable to continue in this manner as students could not achieve competencies that would see them progress successfully into industry.

Firstly, if students are reluctant to work with others, that is peers, instructors, potential users, technicians, and industry experts, then they remain novices with a naïve view of the world and of the field into which they will eventually enter. This sets them up to fail in a profession that demands interactions with numerous stakeholders on any given project. In addition to this, students that do not have adequate experience in giving and receiving constructive feedback, will not be able to reach their full potential as professional designers.

To counter the problem, the academic team initiated an enhanced version of the master-apprentice model to encompass behaviour modelling. The goal was to model the benefits of co-creation to resolve design problems, through the design process, and with exemplary outcomes. Henceforth, the enhanced teaching model involved the academic team undertaking collective creativity, communal problem-solving, and co-creation of a lighting design imbued with emotional meaning, biomimetic symbolism, functional, and light physics attributes. The academic team collaborated by drawing on the strengths of each academic team member to create the design output. Students were able to observe how the academics worked as a team and students were encouraged to constructively criticise the academic team's biomimetic lighting concept. The capstone studio was thus redesigned to foster a stronger awareness of the value of synergistic partnerships to arrive at a robust solution.

3. The enhanced master-apprentice model

The capstone studio employs the master-apprentice model whereby students follow the example provided by the instructor. Budge (2016) asserts that the modelling of professional practice is essential and that students can learn behaviours, design literacy and cultural practice that cannot be learnt in another format (Budge, 2016, p245-248).

It is indisputable that the master-apprentice model has merit in providing students with a learning framework that facilitates cognitive understanding. Collins, Newman and Brown (1986) modelled much of their theories of cognitive apprenticeship on the master apprentice model (Collins, Brown, & Newman, 1986). Their work will be used in this paper to discuss the design studio processes and the relationship between the instructors and students in the capstone studio. The question that emerges here, is exactly what actions, behaviours and directions are the students 'following'.

In the case of design studios at WSU, students undertake a variety of tasks and processes of learning to discover new knowledge. They may observe a demonstration that provides step-by-step methods of inquiry or they may follow a worksheet or notes provided by teachers. At times, students mimic the work of their peers to ensure that they are doing the task at hand correctly. This study looks at whether students mimic or behave like their instructors in order to achieve at a professional level? Learning through imitative behaviour may thus create a new opportunity for instructors in the design studio to engage students in collaborative behaviour. Budge (2016) indicates that there are not many examples of *how* students form an identity of 'being a designer' (Flum & Kaplan, 2012 in Budge, 2016, p. 244). In contrast to the transmissive model of teaching, the academic team in the capstone studio devised their own product design object in order to demonstrate cohesion and professional cooperation between colleagues. This also presented the integrative nature of designers to imbed a lifetime's knowledge from many experiences toward the latest design iteration, leading to inspire the same evolving mindset of actions from the student cohort.

Leon de Bruin's extensive study of the master-apprentice model in pedagogy captures the many structural variations of the method as employed in design studios and other discipline areas (de Bruin, 2019). In contemporary design education, the master-apprentice model is adopted from Walter Gropius, founder of the Bauhaus, and later Laszlo Maholy-Nagy in the New Bauhaus in Chicago (Findeli, 1990). Gropius' constructivist manifesto was to inspire the German nation to work in unison to produce art, architecture and objects to reinvigorate the country after Germany's defeat in World War I (Trimingham, 2019). At the epicentre of all activity was a Master of Form (artist) and Master of Works (craftsman). Eventually, the role of artist was considered superior to the craftsman, and teaching roles evolved accordingly (Bürdek, 2015).

In order to ascertain how the master-apprentice model applies to the capstone studio, it is worthwhile considering its context in relation to the design process. In the capstone studio, project-based learning and collaboration in the design process replicates the process captured succinctly in Sanders and Stappers' illustration (Sanders & Stappers, 2008), shown in Figure 1.

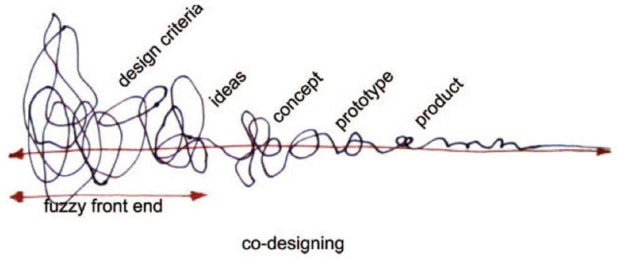

Figure 1 *The growth in the front end [of the design process] as designers move closer to the future users of what they design. Reprinted from "Co-creation and the new landscapes of design" by Elizabeth B.-N. Sanders & Pieter Jan Stappers, Co-Design, 2008, 4:1, 5-18, https://tinyurl.com/vacdgjh*

The illustration in Figure 1, is useful as it represents the journey of co-design as pursued in the capstone studio and as facilitated by the master-apprentice model of teaching which has been extensively researched and established in the cognitive apprenticeship theory (CAT) of Collins, Brown, and Newman (Collins et al., 1986; Bandura, 1997, in de Bruin, 2019, p. 264).

The design studio process delineated in the following section provides a response to one of the research questions, that is how the master-apprentice model teaching method is augmented in the capstone studio at WSU.

4. Establishing the design criteria in the design studio

4.1 Design criteria for the student teams

Students were tasked to design a pendant light or table lamp in small groups comprised of three students (representing a 360-hour time pool including class time during the 12-week semester). The design brief to be completed was a lighting object (3D model) that is:

1. Biomimetic inspired with emphasis on iterative 3D processes
2. Involves ideation and application of additive manufacturing methods;
3. Emits adequate lux [lighting intensity] for a predefined space/place;
4. Ergonomically designed and safe for consumers;
5. Is fitted with a suitable technical package for optimal operation and durability.

Students are often apprehensive in undertaking group tasks as they fear discrepancies in workload, in the perceived commitment of individual group members, and differences in personalities and skill levels (Chang & Brickman, 2018). These are all considered valid concerns, however the role of the academic is to negotiate some of these doubts by setting the scene for collaboration through more trusted relationships. To alleviate some of the reservations, groups were self-assigned. Students were encouraged to imagine themselves working in a collaborative studio business, developing a corporate identity to be used throughout their task submissions also building designer and group identity. Student alliances were reinforced by establishing a brand, thus providing a sense of ownership over their projects.

4.2 Design criteria for the academic team

The academic team was comprised of four lecturers in industrial design, working on equivalent parameters as those delineated in the student design brief. The academic team adopted the corporate identity of Western Sydney University for all activities, as their motivation is to fulfil the goals set by the university.

The workload associated with undertaking this model is an interesting point to consider. The academic workload in the capstone studio is equivalent to four hours per week over a 12-week semester. Face-to-face teaching is delivered using a flexible lecture/studio/workshop format, providing students with a variety of learning scenarios. In most cases, at least two staff were always in attendance, rotating between either actively "doing" the academic project or helping students to achieve the learning objectives through their creative individual and group endeavours.

Wherever possible, the academic team modelled behaviours within the prescribed studio time and in front of the student cohort. When the academic's light was completed outside of class, this was considered equivalent to the workload time allowances provided for usual tutorial preparation activities within an academic teaching workload. A nominal percentage of project activity was undertaken outside the workload; however, the team members understood the benefits of the interaction and were willing to participate, nonetheless.

4.3 Augmented master-apprentice model (Design Criteria)

The design criteria imposed the same limitations to students and academics alike. Both groups needed to navigate barriers in group interaction with factors such as peer commitment, time constraints, external pressures, diversity of knowledge, and skill levels all playing a role in determining the success of a product. Collaborative endeavours are thus influenced by physical limitations, technical understanding, and knowledge in the design process.

In this early stage of design development, it is typical for instructors to define the project brief and then assist students in learning how to resolve the brief (Emam et al., 2019, p.164). This is generally done by limited *modelling, coaching* and *scaffolding* (Collins, 1989 in de Bruin, 2019), yet there is little evidence in the literature review undertaken by the authors where the instructors resolve the same collaborative project as their students and in parallel to the students. The augmented master-apprentice model thus provides a new model that encompasses, not only coaching, but active and immersed participation. Emam et al. (2019), indicate that "during early stages of a collaborative model, the instructor must help to develop the students' teamwork skills" (Emam, Taha, & ElSayad, 2019, p. 164), which is pivotal to the success of the capstone studio.

5. Concept and idea development in the design studio project

5.1 Concept and idea development in the student teams

Information gathering was assumed through desk research and a self-directed field trip to local lighting showrooms or exhibitions. This task was intended to encourage group-bonding by sharing of contact information and identifying availability to meet outside of class time.

Informed by the field trip, the next stage was to ideate through drawing. Observations found that several student teams were perplexed with the brief; many of them had not designed organic objects and did not understand the notion of 'modularity'. During this *articulation* phase (Collins, 1989 in de Bruin, 2019) refinement in the understanding of concepts and procedures (de Bruin, 2019, p. 265) was necessary and some teams needed in-depth consultations with instructors to ascertain the meanings of these terms, hence groups returned to research rather than moving forward with the drawing phase. The in-depth consultations were useful in this collaborative studio, as it presented scope for *co-thinking.*

Observations furthermore indicated that student groups assigned the drawing role to one group member that they perceived as having the greatest competency in drawing. Drawing presents a method by which to communicate creativity though visualisation. This is an example of inclusivity and synergy, as abstract verbal ideas are translated into a two-dimensional form of communication.

5.2 Concept and idea development in the academic team

In parallel to the students' field trip, academics also gathered sources of inspiration by undertaking desk research, field trips and the collection of physical lighting examples.

The academic team undertook a process of creating conceptual sketches for the lighting design, delegating this task to the academic with expertise in hand-drawing. The Master augmented inputs were characterised by the shared in-class and summarised extra-curricular class experiences outlined below (see also Table 1):

- The concepts were generated in front of students, so students could witness the academics doing visual searches, preparing drawing equipment, and generating thumbnail sketches and more resolved sketches.
- Students were encouraged to offer feedback and suggestions for improving the designs. Beyond output standards, students were involved in decision making as teams whereby unexpected, yet welcomed, thoughts, ideas and alternate solutions could surface.
- The exhilaration for students becoming masters rather than apprentice even for a moment was high during the *Critique-of-Masters* sessions and provided a sense of arrival to the design profession where co-creative methods respect design career experience yet reach out for new contributions from all team members via a dynamic hierarchy.

- During this idea-generation phase, the academic staff team also participated in email exchange to share progress sketches and resolve product detailing issues for manufacturing.

5.3 Augmented master-apprentice model (concepts & idea development)

In some design studio learning scenarios, the learning is transmissive as academics direct the flow of knowledge to students. In cognitive apprenticeship, students undertake activities in *articulation* and *reflection* such as explaining their findings to instructors and peers (Collins, 1989 in de Bruin, 2019. p. 265). As an augmentation to this process, the capstone academic team also shared their field trip experiences, exemplifying breadth of research and stimulating creative thinking. To model teamwork, lectures were undertaken in a team-teaching format with two or more academics presenting content related to the topic. Students were continually invited to offer insights, evaluations, reflections and input during lectures and studio time.

It is significant to note that the email exchanges between academics that were shared with the cohort included at times, examples of negative feedback concerning aesthetic development, technical issues, and foreseeable manufacturing problems. The students were surprised to read the academic team's correspondence and of the willingness of the academics to change the design many times in order to continually improve the outcome. This accelerated student confidence and noticeable change in some student team member's mindsets through engaged activity and design progression.

6. Prototyping and product outcomes in the design studio project

6.1 Prototype and product outcome by the student teams

The student teams were encouraged to produce a lighting object that was of suitable quality for display in the WSU 26th Annual graduate exhibition, *Widevision*. Initial prototyping was undertaken by students by forming extruded polystyrene foam into three-dimensional form studies or by producing scale models using 3D printing methods.

Successful teams in the capstone studio were able to establish a strong group-work ethic, producing models of a high resolution to communicate the concept with members contributing equally to the product design process and outcome. In some cases, teams worked outside of the required class time, at one another's homes, or in the university makerspace/workshop to complete a quality product. In a few cases, student groups worked beyond the scope of the teaching semester. This demonstrates the essence of social learning, as espoused in Lave and Wenger's *communities of practice* (Lave & Wenger, 1989 in Cox, 2005) where participants are working alongside peers that have like-minded goals, or as a "mutual participation in practice" (Cox, 2005, p. 529).

6.2 Prototype, product outcomes and methodological influence by the academic team

The ultimate goal for the participating academics was to create a physical model of the team's lighting design and to model collaborative behaviour so that students could understand how collaboration occurs in a design studio, as students had not yet participated in the 10-week design industry placement following this subject. The academic team's initial aim was to present a design solution in an equivalent timeline and using the same project constraints given to students.

In producing the final light, the academic team experienced some of the problems encountered by students. Namely, financial constraints and availability of 3D printing resources.

6.3 Augmented master-apprentice model (Prototype and product outcome)

During tutorials, the academic team were working on the CAD model real-time, with shared-screen projection in the classroom to show design resolution. The academics demonstrated examples of design iteration, manufacturing considerations, and steps in creating 3D CAD models for the academic light object. Once again, email exchanges between staff were projected on screens as evidence of ongoing feedback and how the design is pushed to ensure quality and manufacturability.

The role of master-apprentice was enhanced in scope to demonstrate and exemplify cooperation, communal decision-making, strategies for overcoming barriers, group negotiation skills, and actioning feedback. The intention is that students observe the synergy of working in teams and model the behaviour undertaken by staff to meet the design phase milestones.

7. Meaning and relevance of 'collaboration' in the design studio

The meaning of collaboration in the design studio comprises many activities as presented in the above narrative and matches the definition established earlier in this paper. It as a teaching strategy that is applied with small teams of students of different levels of ability, and where all team members participate to deliver the assigned task (Emam et al., 2019, p. 164). If we return to the initial definition, we see that students and academic teams in the capstone studio achieved all the elements prescribed, with the added non-tangible [but present] activity of modelling professional behaviour, that is, how to 'be' a designer.

Modelling of such behaviour by both students and academics reinforces the theories of *communities of practice* and situated learning (Lave and Wenger, 1991 in Cox, 2005, p. 528) and may be used to cultivate a rich learning experience through social learning where individuals with common interests, skills and knowledge participate in achieving a communal goal. The theory conceived by Lave and Wenger is explored in several studies of organisational learning, and in higher education pedagogy (Artemeva, 2006; Cox, 2005), and fittingly applies to design studio teaching. The application of *communities of practice* for industrial design studio learning is very useful as this capstone studio exemplifies working in teams to resolve a group design challenge and the co-created outcome is derived from the combined efforts of all team members.

Table 1 below, is a summary of specific examples of behaviour modelling in the capstone studio:

Table 1 Examples of academic behaviour modelling in the capstone studio

Design Process	**Opportunities for student observation**
Research phase	Activity undertaken by academics during tutorials: • Academics undertake visual searching (using search engines such as Google) to inspire design concepts • Visual searches are projected on screen so students can see how the research process • During the lecture, academics also share images of their own site visits, exhibition visit and visual research findings
Conceptual development phase	Activity undertaken by academics during tutorials: • Academic staff are prepared with suitable equipment to undertake the conceptual drawing phase • Academics sit with students at student tables to draw initial ideas; soliciting feedback from colleagues and students throughout the process • Drawings are displayed on tables for feedback/critique, demonstrating the range of work and quantity of work that can be achieved in limited time frame • Staff and students select the most viable lighting design to pursue • Academic emails (between staff) are shared with students via screen projections during tutorials to show e-collaboration process
3D CAD modelling phase	Activity undertaken by academics during tutorials: • The academics share CAD models with students via screen projections to show how the model is generated; CAD model is updated in 'live' mode during the tutorials • Academics provide ongoing feedback to each other to suggest how the design can be improved. • Academic emails (between staff) are shared with students via screen projections during tutorials to show e-collaboration process

Technical package resolution	Activity undertaken by academics during tutorials: • The academics share screen projections to show searches for suitable technical package • Academics provide ongoing feedback to each other to suggest potential technical packages • Academic emails (between staff) are shared with students via screen projections during tutorials to show e-collaboration process
3D printing phase	Activity undertaken by academics during tutorials: • The academics share screen projections to show development of final lighting solution • The academics consulted with technical staff on 3D printing requirements during tutorial time; students could observe these meetings. The costs of model-making were shared with students.

Positive working relationships is crucial to the learning environment to ensure students are confident enough to seek advice and are proactive in responding to feedback. Where students did not attend classes regularly or did not participate in critiques, the projects did not fully develop, and in some cases, groups were not able to achieve the milestones defined in their own project timelines.

In the self-evaluations conducted by the student teams, groups were asked to reflect on their experience in the studio subject and to consider what they had discovered during their journey through the project. A sample of comments was obtained from six student groups, shown in Table 2.

Table 2 Student Groups-Self evaluations

Student Groups	**Self-Evaluations**
Group A	What have we learnt in this unit: • To create an aesthetically pleasing design • We could see it in a boutique • The piece is flexible and could be mounted on the standing frame and also to the ceiling with additional hooks that could be placed on top of the frame If we were to do the project again, how would our work change: • We would choose a softer brightness bulb • Make the modules longer • Make more modules • Hook the modules instead of threading through the frame

Group B	We have learnt the following in this unit: • The importance of keeping a process diary/portfolio/ journal • Teamwork and job distribution New skills that we have learnt: • Vacuum forming • CNC machining • Laser Cutting • Soldering
Group C	There were many challenges faced during the project. Exploring the particular themes of organic and natural forms was a new experience and a unique way to design. The process of simulating real world production was also a new challenge and required much more consideration and detail when designing the product. While a challenging project throughout, overcoming these challenges and producing a final model brought great practice and new skills that can be utilized to advance our design careers. It granted us the experience of designing products in real world scenarios and allowed us to understand all the considerations related to a production. Overall, the light design we created is unique and interesting in many aspects and was not only a valuable experience to develop, but it is a piece worth showcasing to future clients to present the skills we possess. We have new insight into proper design projects and can carry the skills we learnt into future endeavors and continue designing and expanding our expertise.
Group D	As part of our design problem, our main goal was to meet the demands of the clients (our instructors). We were required to have a modular component repeating throughout the design and we have achieved this. From the onset we knew that we wanted to appeal to budding young entrepreneurs of ostentatious taste. We wanted our light to be utilized as Interior Mood Lighting, High-Scale Domestic Décor, Renewed Aesthetics for Offices, Hotels and Restaurants, as a means of Intrigue; a conversation-inducing piece at social events, and for it to provide general illumination to venues.

Group E	Good aspects of the project: • Our module was redesigned several times. • Our group tested every module by 3D printing 1 module piece out. • Reduced assembly part for 1 module. (From 3 pieces to 2) • We had really good communication throughout the semester. • Good team effect. Everyone did the work equally. Bad aspects of the project: • Printing took quite a bit of time, giving us less time to work on our final model. • We made a mistake at first by painting a module. • One of our test-modules showed that it was too thin and brittle. • Most people in our group had work causing less time for meet ups. What can be improved: • Bigger overall scale • Better cable management • Give 3D printing a bigger priority. • More meetups to finalize and work on our designs and models. • Better hook attachment design.
Group F	What went well in our project? • Good research technology • Concept development • For our project we went through various stages back and forth with the clients and the manufacturing room to produce our final design. What can we improve on in future? • Testing • Better prototypes • More collaboration with our client Future possibilities? • Using improved manufacturing techniques • Various materials testing which may better suit our design

For six groups, their respective efforts in the capstone studio was open to public scrutiny at the annual *Widevision* exhibition, showcasing exemplary student work in the course. Visitors to the exhibition could speak directly with students and guests provided many positive comments on the finished models. The lighting works revealed a high level of care and competency and were demonstrative of the excellence that can be achieved through robust collaboration. Whilst the total number of exhibiting works is low, it is significant to note, that the objective of the capstone is to engage students in collaboration regardless of whether they completed the light or not. Table 3 below, indicates the number of exhibition-ready models.

Table 3 Number of Design Studio Teams and comments on exhibition-readiness.

Models/product output	**Student Groups**	**Comments/Reflections**
Total number of student lighting groups	14	Each group comprised of either 2 or 3 students.
Total number of exhibition-ready models, that is, models are complete and of high finished standard	6/14	These teams had excellent group collaboration; excellent channels of communication with staff; lights were completed to a high standard; excellent attention to detail; motivated group membership; excellent attendance in studio.
Total number of incomplete models with potential for exhibition upon completion	6/14	These teams were unable to print sufficient modules due to financial limitations; groups encountered model making problems; in some cases, the groups were not able to achieve milestones.
Total number of models complete (submitted for marking) but not ready for exhibition.	2/14	These teams submitted objects that were not resolved; technical package not tested for safety; team member attendance in classes was sporadic; limited communication with instructors; modules were not structurally sound; these two groups experienced external interruptions and could not meet milestone dates.

One of the questions we must ask ourselves as educators is why is it important to offer opportunities to collaborate in the design studio? In industrial design, the collaborative capstone studio prepares students to enter an industry that relies on empathy with humans from broad backgrounds, cultures and with diverse needs. As such, it is essential to equip students with the experiences where they must adapt to the dynamics of working in co-operation with peers and academics rather than relying on their own limited skills and knowledge. A successful “real-world” studio relies on the synergy between workers in order to drive the company’s mission and goals, and hence the modelling of an academic *being* a designer brings many insights to the fore. If the instructor models professional practice and collaborative activity to undergraduates, then students will have improved confidence when working on “real-world” problems and in “real-world” teams.

8. Conclusions

There is much scope to further improve the student experience in the capstone studio. A retrospective survey of participants would help to further decipher methods for improving the subject, although the insights presented in Table 2, are a good starting point. Changes to the capstone studio could include co-design, where students and academics work on a combined project, the academic team could work towards submitting equivalent tasks with similar budget constraints as students, as well as more concrete decision-making strategies for negotiating ideas, and building collaborative skill sets such as how critiques unfold or how to negotiate competing ideas. Students could also undertake a more formal review of academic projects creating a sense of belonging to the profession, and 'being' designers. This activity elevates the student role to that of an emerging professional, where their judgements are informed, justified and valued.

This paper thus argues that by being engaged, immersed, and active in the design process, and by 'being' a visible designer, that the path to achieving a common goal is enriched. This synergy is paramount to success and encourages students to have pride in the output. This augmented master-apprentice model places the student-team at the epicentre of learning. With six out of 14 groups exhibiting their work, the model has shown measured success with room for enhanced outcomes in the next delivery. No works were selected for exhibition from the same capstone studio in previous years, hence the challenge is now to increase the number of exhibits for subsequent exhibitions.

The industrial design academics (instructors/clients) are active participants in making and negotiating outcomes. It is of note that the academic team's lighting design was not completed for the exhibition. The academic team gave preference to all student endeavours as a priority. The academics met to discuss the avenues for producing the light and it was determined that the academic light may result in a sense of undesirable 'competitiveness'. The academic team did not wish to draw attention to their own efforts but rather to elevate the works generated by the student teams.

What did the academic team learn in the process of undertaking this teaching approach? Academic staff modelling designerly behaviour through professional practice provided students assurance that continual conceptual and detail iteration informed by communal research and constructive critique was essential for successful project completion. This was quantified through attainment or non-attainment of exhibition ready status. The capstone studio tasks are not intended to redefine the roles of master and apprentice, rather the intention is to moderate the distinctions to maximise collaborative synergy through professional practice modelling. This resulted in heightened student confidence that is supported by informed design decision-making thus preparing students for employment and co-creative practice.

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