Refining a pedagogical approach for employing design thinking as a catalyst

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Abstract
There is an increasing interest in design and creative thinking processes in the Sciences, Technology, Engineering, and Mathematics (STEM) and health education disciplines. Many new degree programs are integrating design thinking into their syllabi, with the intention of bringing creative problem-solving methods to these disciplines. In reality, the exposure these students get is minimal, and it does not provide enough foundation for them to use the knowledge and apply the process(es) in real-life situations. There is an increased awareness of the importance of design thinking in the innovative process. More and more STEM, business, and health establishments are embedding trained designers into their research teams – yet many designers are not equipped to work on interdisciplinary teams. Design students tend to approach problems more intuitively, opportunistically, and build on creative leaps of imagination whereas, STEM and health disciplines are often more algorithmic, systematic, and rationale. This can often generate tension in interdisciplinary teams, especially when traditional disciplines (e.g., Engineering, Sciences) are integrating relatively newer thinking (e.g., design thinking).

In this paper, we share the outcome of a phenomenological study on a high-functioning interdisciplinary team working on a health innovation project focused on aging with a disability. This case study illustrates the skill set needed for designers, health and technology professionals to make a significant contribution to its overall outcome. We identified key attributes that contribute towards being an effective member of interdisciplinary teams. Based on this study, we propose a pedagogical approach to better equip design, STEM, and Health students to be more competitive in changing economic expectations and ensure more impactful design outcomes.

Keywords
interdisciplinary team, design thinking, design education, STEM education, design research.

Introduction
There is an increasing awareness that design thinking skills play a catalytic role in innovation outside the design domain. This realisation has resulted in an explosion of educational programs that integrated design thinking skills in their respective disciplines. This trend is especially evident in the Sciences, Technology, Engineering, and Mathematics (STEM) and health education disciplines (van der Sanden & de Vries, 2016). There is an awareness that the inclusion of design thinkers in interdisciplinary teams produces much more effective outcomes.

Over the past decade, there has been increasing acknowledgment of encouraging a wider awareness of knowledge while concurrently developing a deeper level of expertise in a particular area. This is referred to as a T-Shaped educational model, expertise in one profession, and awareness of related professions (Baratta, 2017). This educational model facilitates incorporating design and creative thinking skills as part of breadth knowledge and more holistic thinking. These efforts have resulted in an appreciation of design skills and designers in STEM and Health disciplines. However, the attitude and behaviour involved in a problem-solving activity are quite different in these disciplines, which may result in ineffective and unproductive teams.

This case study builds on our earlier research (Reddy, McDonagh, Harris, & Rogers, 2020a) and further explores this phenomenon using a high-functioning interdisciplinary team working on a health innovation project focused on aging with a disability to illustrate the skill set needed for a designer to make a significant contribution in an interdisciplinary team.

Design

> *"The International Council of Societies of Industrial Design gives it credit for creativity, but then complicates it with grandiosity: "Design is a creative activity whose aim is to establish the multi-faceted qualities of objects, processes, services and their systems in whole life cycles. Therefore, design is the central factor of innovative humanisation of technologies and the crucial factor of cultural and economic exchange" …A more recent definition from proponents of design thinking emphasize design as a problem solving that creates new, useful products, places, communications, or experiences."* (Giudice & Ireland, 2013, p. 14)

Definition of design varies immensely based on who is writing about it. This often creates an impression that design as a discipline is superficial and perceived to have a low value. In the context of this paper, we provide few snapshots of design, design thinking, and design attitude to provide a baseline to what we refer to as 'design' and the value of 'design.'

Lawson (2006) described design activity by contrasting how scientists and designers differ in solving a problem. Lawson pointed out that scientists use a strategy to analyse a problem to find an optimal solution systematically. In contrast, designers tend to explore the problem cursorily, and proceed to suggest a variety of solutions, and settle for one that is most satisfactory. In other words, scientists use problem-focused strategies and designers use solution-focused strategies (Cross, 2008).

Nelson and Stolterman (2014) provided further insight by contrasting how scientists, artists, and designers approach their activity. Scientists are extremely focused on precise, accurate, logical, and validated processes so that the outcome of the process can be 'trusted.' Artists are not particularly concerned about the process but are more interested in self-expression and in getting the desired outcome. Designers are focused on both the process and the outcome, aiming to use the process appropriate for the desired outcome in satisfying the needs of others. In other words, for designers, process and outcome are entwined and equally important.

This is why Rittel and Webber (1984) referred to design problems as 'wicked.' Wicked problems do not have a definitive formulation; the problem and solution are linked in such a way as to define the problem, a designer has to attempt a solution (Cross, 2008; Lloyd & Scott, 1994).

Visser (2009) noted that the outcome of a design process has no one definitive solution that can be termed as correct. An ill-defined problem has potentially several acceptable solutions, and designers settle for what they deem the most satisfactory (Simon, 1975).

In short, design is a problem-solving process or an activity towards finding innovative solutions for complex/ill-defined problems. The problems in our case study are the everyday challenges faced by older adults with mobility disability.

Effective Team

Our global and interdisciplinary Design Team originated at the University of Illinois Urbana-Champaign (USA) to collectively design solutions based on the everyday challenges experienced by older adults with a mobility disability. We conducted an archival study to understand these challenges using data derived from the Aging Concerns, Challenges, and Everyday Solution Strategies (ACCESS) study (Koon, Remillard, Mitzner, & Rogers, 2020). Members of the ACCESS team consists of a mix of Community Health, Exercise Science, Gerontology, Human Factors, and Psychology fields all within the USA. The collaboration among these fields brought insight on the design and implementation of a large-scale interview study that collectively illustrated the various challenges those aging with a mobility, vision, or hearing impairment face in their everyday activities, ranging from activities of daily living (e.g., toileting and bathing) to using transportation. In addition to the everyday challenges, the ACCESS study aimed to understand how those aging with a disability respond to their challenges—for example, using technology or receiving help from others.

With the plethora of data from the ACCESS study, our interdisciplinary Design Team came together to understand the challenges those aging with a mobility disability have with transportation due to its association with various aspects of health. A successful team is often a diverse mix of behaviours ("The Nine Belbin Team Roles,"). Our team members came from a mix of Community Health, Empathic Design, Human Factors, and Interaction Design. They bring experience as researchers and educators collectively from the USA, India, United Kingdom, and Australia. Belbin Team Roles stated that there are two parts to any team: first is the functional role, which is the skill-set a person brings to the team. Second is the team role, which is the behaviour of a team member in terms of contribution to its effectiveness (Belbin, 1991). Nine roles can be roughly grouped under three categories: (1) thinking-oriented (Plant, Monitor, Evaluator, and Specialist); (2) action-oriented (Shaper, Implementer, Completer Finishers); and (3) people-oriented (Coordinator, Team Worker and Resource Investigator). Each of these roles plays a critical part during a project life cycle (Belbin, 2010). The following is the involvement of team roles at different stages of a project.

- Ideation – Plant and Resource Investigator
- Evaluation – Monitor Evaluator
- Implementation – Implementer
- Completion and deployment - Completer Finisher

Designers often play the role of a Plant in interdisciplinary teams. Plants can tackle complex problems innovatively through their creative thinking skills. However, they tend to get distracted or may pursue an impractical idea. To make the most out of a Plant you need a

Coordinator who can channel their talents and help keep their ideas aligned with the team's needs. Plants can take leadership roles when supported by a Monitor Evaluator and or an Implementer. Both help keep the Plant rooted in reality. There should not be too many Coordinators or Plants in any team, and they should be involved at the right time of a project life cycle ("Belbin and Project Teams," 2020).

In our Design Team, we have a well-defined Coordinator, focused Monitor, and a Plant. The team is effective because there is minimal overlap in team roles, and they are involved only at the right time of the project life cycle. Most importantly, all the members have experience in working in interdisciplinary teams, as well as a shared goal of supporting older adults with mobility disability.

Case Study Implications for Design Education

This case study illustrates the complexity of finding solutions for wicked problems; the needs for disciplinary diversity of team members; and the team roles required for success. We use this example as the base from which to evaluate design education. Are current approaches to design education providing students with what they need to effectively contribute to teams that are tackling the wicked problems in society? We propose and amend approach that focuses directly on the value of incorporating design thinking.

What is missing in design education?

Design is the driving force of the new economy, illustrated in Table 1, which was adapted from 'Designing a Future Economy: Developing design skills for productivity and innovation" by Design Council (2018). It is well documented that design skills contribute to innovation in a discipline outside of itself. This implies that designers are working in organisations (e.g., health sector, law sector) that are not their traditional destination (e.g., creative industries, design consultancy (Design Council, 2018). What used to be an exception, an unfamiliar career path, is becoming a norm in the current economy.

Competencies expected in the new economy

The changing requirements of the new economy will be expecting a different set of skills from future designers, skills that are not part of their current training. This presents some serious challenges to design education to bridge the skill gaps sooner than later.

Table 1: Future demand for design skills [6]

Skill	Importance to Design Economy occupations (Importance Premium)	Predicted future demand
Operations analysis	23%	22
Fine arts	15%	51
Programming	22%	58
Computers and electronics	5%	60
Geography	4%	61
Visualisation	3%	64
Design	40%	68
Engineering and technology	18%	76
Building and construction	9%	82

Traditionally, the following discipline-specific skills highlight good designer skills and knowledge (Dym, Agogino, Eris, Frey, & Leifer, 2005); additionally, designers are expected to possess the ability to:

- Tolerate ambiguity associated with the interactive process of divergent-convergent thinking,
- Think holistically by switching between micro and macro-level thinking,
- Make decisions in uncertain conditions,
- Think as part of a team,
- Communicate using the appropriate language of design.

What is missing from this list is the skills and knowledge required to work in fields outside of traditional establishments. Skills that are essential for career progression and taking on leadership roles in an establishment.

As an example – we are already seeing transition in skill requirements. what used to be defined as 'graphic design' is today referred to as 'UX design'. LaBarre (2016) wonders if tomorrow these UX designers be avatar programmers, fusionists, and artificial organ designers?

> *"A new wave of designers formally educated in human-centered design—taught to weave together research, interaction, visual and code to solve incredibly gnarly 21st-century problems." (Miller,cited in LaBarre 2016). (LaBarre, 2016)*

Similarly, recent research shows how STEM areas are realising importance of ‘design’ in their professional practice (Petrina; Semouchkina, 2021). It is imperative both Design and STEM education should address the growing demand for both interdisciplinary hard skills and soft skills such as ability to work and communicate in teams with diverse disciplinary members.

STEM to STEAM

> *“In the Western tradition, the right answer was soon identified as an outcome of rational thought, using the protocols of the scientific method.” (Nelson & Stolterman, 2014, p. 30)*

Research suggests that the inclusion of arts education in STEM curriculum can positively impact students’ creative and critical thinking abilities. It is also known to improve abstract thinking skills, spatial reasoning and openness to new ideas, which are qualities that are essential for innovative problem solving (Perignat & Katz-Buonincontro, 2019).

STEM fields are adopting art and design pedagogy to enhance creative thinking skills in technological disciplines (Costantino, 2018). With the addition of art and design to the technological disciplines, capital ‘A’ was introduced into STE’A’M. STEAM curriculum adoption in high schools is increasing drastically and is already producing positive results. One of the most visible outcomes is an increase in design awareness and its importance in the technology development process. This trend is resulting in an increased presence of designers in traditional STEM establishments. Although STEAM curriculum increases awareness and importance of creative thinking in STEM areas, it does not impart a depth of knowledge for its practical implementation. Nor does it fully prepare to work with designers in interdisciplinary teams.

Designers often in a Plant role with a ‘work alone’ attitude find it hard to get accepted into teams that are not aware of their behaviour or value ("Belbin and Project Teams," 2020). Similarly, such work-alone Plants find it hard to cope with a structured way of doing things. Further, design and the other creative fields tend to attract more visual thinkers. Often those who have struggled with the traditional forms of communication (e.g., written word). From the authors' experience, up to 30-40% of design students tend to have varying degrees of dyslexia and increasingly attention deficit disorders.

> *“People who are dyslexic seem to have an abundance of creative thought.”Shaywitz cited in Rhodes (2016).*

Although this may sound alarming to those outside of design, it is a good indicator of their ability to identify the lived experience slightly differently and offer unique solutions that a more traditional thinker may not offer and problem-solving. They tend to view the end goal rather than the incremental steps in the process. Being ‘wired’ differently is an advantage when your goal is to reimagine how the lived experience could (and should) be.

Most of these issues can be resolved through proper training and experience. However, most design curricula are situated in an intensive creative environment that encourages students to adopt individualism and gut feelings towards problem-solving. Thus, Plants emerging from these environments are often not good at communicating in a language appropriate for an interdisciplinary setting. This approach, at times (and to non-designers), may appear unrealistic and irrational as we move towards more interdisciplinary solutions. There is already a realisation of these limitations, and there are numerous examples of integrated programs where design and technology students work together (Nae, 2017). The integrated learning environment is often extremely design-specific, where technology students get immersion in design programs rather than the other way round. As a pilot program, authors have run an integrated course for design and technology students at the University of Canberra. As expected, technology student enrolments outnumber design students by 9:1 over two consecutive years. In the new MS in Health Technology program at the University of Illinois Urbana-Champaign, students have primarily enrolled from either engineering or behavioural science backgrounds, not design. However, they are encouraged to take design courses as electives to integrate design thinking in their capstone projects.

Whereas the emerging new breed of the STEAM cohort is adapted to working in interdisciplinary teams, sadly, designers in this cohort are still not adequately equipped to work in these environments.

Design thinking and STEAM Leadership

> *"Now that companies need agility and imagination, in addition to analytics, we believe it's time to turn to Design as a model of leadership." (Giudice & Ireland, 2013, p. 13)*

The growing importance of design-thinking to identify and solve complex problems has greatly influenced the perception of its significance and contribution to the economy. Thus, transforming 'design' into a new pathway to leadership roles. This change in perception is opening up new leadership roles for designers within both business and education. Giudice and Ireland (2013, p. 17) identified six defining characteristics of design leaders; Change Agents, Risk Takers, Systems Thinkers, Intuitive, Socially Intelligent and, GSD ("gets shit done").

The opportunities and advantages presented by design thinking are well understood by STEM and Health areas. Furthermore, they have realised that their education programs lack training in creative thinking and the ability to deal with ambiguity. However, they address the gap in their discipline by introducing art and design subjects into their education programs, especially programs at the high school level where there is a significant amount of work underway (Bequette & Bequette, 2012).

STEAM Limitations

STEAM curriculum increases awareness and importance of creative thinking in STEM areas; however, it does not provide enough immersion to integrate the knowledge organically. Most importantly, the current STEAM curriculum is not integrated deeply enough to dispel stereotypes about design practice being superficial (i.e., design is just about styling, defining form, colour). This could also be due to a lack of clear understanding difference between Art and Design. Although both Art and Design share similar creative thinking strategies, Art is more focused on producing experiential/aesthetic artifacts. On the other hand, designers are more engaged in using the design-thinking processes to solve complex problems.

Adding designers to interdisciplinary teams does not necessarily solve the problem. The imbalance of perceived value of the contribution by designers needs to be corrected first. Moreover, value perception is essential for a 'welcoming and respectful culture' for designers when engaging with engineers, scientists and technologists.

STEM to STEMHD (emerging discipline)

Art education in STE'A'M provides insights into the creative thinking processes. However, Design education is needed to use creative processes in solving complex problems. Further, the Health / Medical discipline is currently grappling with wicked problems, where the importance of design thinking is felt strongly. Perhaps the STEM needs to be expanded its scope to reflect current needs - Science, Technology, Engineering, Math, Health and Design (STEMHD). The following are a few examples that supports a need for more STEMHD education.

In the Human Factors and Aging Laboratory (HFAL; www.hfaging.org), the members are from multiple disciplines and all research project teams are intentionally interdisciplinary to benefit from different modes of thinking and problem-solving approaches. Since inception, the field of human factors has been interdisciplinary, with the goal of "optimizing human performance in systems and reducing errors by designing those systems to accommodate the capabilities and limitations of humans from a perceptual, cognitive, and physical perspective (Rogers & McGlynn, 2019, pp. 1-16). Consequently, by definition, design thinking should be incorporated into human factors research and application. Current members of HFAL project teams hail from architecture, biomedical engineering, communications, education, gerontology, industrial design, industrial engineering, informatics, media, nursing, occupational therapy, psychology, public health, speech, and social work. The following two examples illustrate the role of design thinking.

First is the ACCESS project, previously described. This large corpus of data was collected to understand the everyday activity needs of people who are aging with long-term perceptual and physical disabilities. The impact of this understanding is best realized with engagement of designers to interpret those data through their unique lens. For example, our Interdisciplinary Design Team has utilized the qualitative interviews as "sparks of innovation" to transform challenges into opportunities (Reddy, McDonagh, Harris, & Rogers, 2020b). In addition, an architecture student has been evaluating the interview data to develop environmental design solutions (Ramadhani & Rogers, 2020).

The second example is in the context of human-robot interaction (HRI) with mobile-manipulator robots to support older adults in their home. Early work with a large, heavy, expensive robot called the PR2 established the potential value of domestic robots that could support everyday activities (Beer et al., 2017; Smarr et al., 2014). The next generation of design for a mobile manipulator robot has been developed by Hello Robot and is called Stretch (https://hello-robot.com/). The interdisciplinary HRI team incorporated design thinking and problem-solving approaches to develop a smaller, lighter-weight, less-expensive, but similarly functional robot; see Kadylak et al. (in press) for initial human factors evaluations. We are currently using the case-study approach often incorporated in the design field to garner an in-depth understand of the unique needs of one person who has quadriplegia, and his care partner, to guide the next iterations of the tools that Stretch should be outfitted with to support functional independence for a variety of tasks. We advocate the participatory design approach as potentially very useful for HRI advancements (Rogers, Kadylak, & Bayles, in press).

The above examples clearly demonstrate how an interdisciplinary team is the need of the hour. The current culture in the industry expects that working in interdisciplinary teams is a given, and our students should be prepared for the challenges this form of collaborative working expects. Both design and STEM curriculum needs to align with the changing nature of the workforce. In this regard, recent experiments on integrated bachelor's degrees are in the right direction, but much more needs to be done. Most of these programs have addressed limitations in interdisciplinary knowledge (functional role). The problem has another facet – attitude (team role). Attitude and resulting behaviour are deciding factors of a person's role in a team.

Interdisciplinary Education

Although we are seeing progressively more awareness in multiple disciplines about design, design education is yet to catch up with preparing their students in return. Figure 1 illustrates the gradual overlap of disciplines that we are seeing in practice. This pattern is not yet reflected in preparing the future workforce.

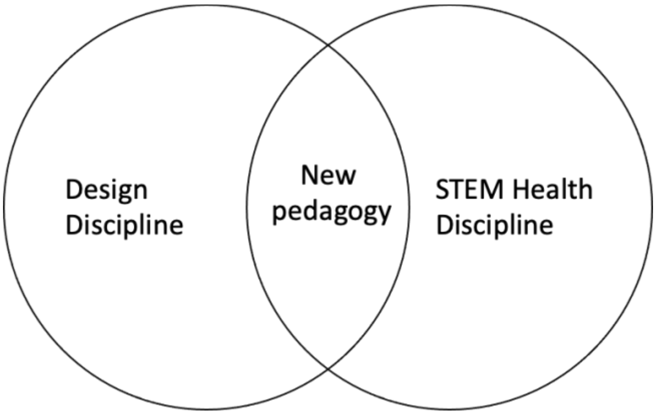

Figure 1: The intersectionality of STEM, Health disciplines, and design to create a new interdisciplinary design pedagogy approach for design students.

A current challenge in interdisciplinarity in design and STEM+Health education is that it is restricted to individual courses and their instructors. Its benefits are largely dependent on students' openness to the idea, their profile, and aptitude to make sense at a macro level (Self, Evans, Jun, & Southee, 2019). The new curriculum must address this at the systemic level to change the complete outlook of the program.

Design Mindset

> *"To be a practicing designer therefore is not only a matter of skill and knowledge. Design praxis also requires personal integrity and proficiency, in conjunction with a design process that is compatible with and reflective of the designers' character and competence." (Nelson & Stolterman, 2014, pp. 239 - 240)*

Michlewski (2016) made an important distinction between design thinking and design attitude. Meaning, a design-attitude approach to problem-solving cannot be compared with using a process such as a design-thinking toolkit. Design attitude is a frame of the mind of a person who uses the design-thinking process to produce the intended results. Design attitude is a way of being that forms part of professional culture of designers inculcated through deep immersion or "situated learning." Michlewski (2016) identified five distinctive aspects of 'designer attitude'.

1. Embracing uncertainty and ambiguity
2. Engaging deep empathy
3. Embracing the power of five senses
4. Playfully bringing things to life
5. Creating new meaning from complexity

For a designer, ‘design attitude’ or ‘design mindset’ is a defining factor that cannot be negotiated. Design attitude encourages working towards solutions that are "assertion-based” rather than “evidence-based.” Emphasis is more on proposing novel solutions that challenge the status quo (Michlewski, 2008). On the other hand, for a researcher, the ‘scientific attitude’ is more evidence-based, objective observation and not concluding anything that is not based on or supported by facts (Rao, 2010).

In an interdisciplinary team, we see these two contrasting attitudes work together towards a common goal. To work on an interdisciplinary team, one needs to be prepared and equipped to switch their thinking approaches based on their team role (De Bono, 2017). The skills required to be flexible in thinking approaches are missing from the current design curriculum. To help acquire these skills, the proposed design pedagogical approach will extend the cliched T-skill model by developing attitudinal skills as part of their breadth-knowledge.

STEMHD Pedagogy Approach

Taking from Edward De Bono’s six thinking hats (De Bono, 2017) encourages one to think outside the comfort zone and gain an empathic point of view. The proposed pedagogical approach encourages students to take a breadth of courses in the discipline in a much more structured fashion, from introductory courses to a level that allows them to gain adequate skills and knowledge. Finally, leading to capstone projects where they are encouraged to adapt attitudinal thinking of breadth discipline through ‘situated learning.’ Meaning, if a design student is taking an ‘Introduction to Programming’ course, they will play the role of a programmer in a collaborative project. Similarly, a programming student in a design course will take on the role of a designer.

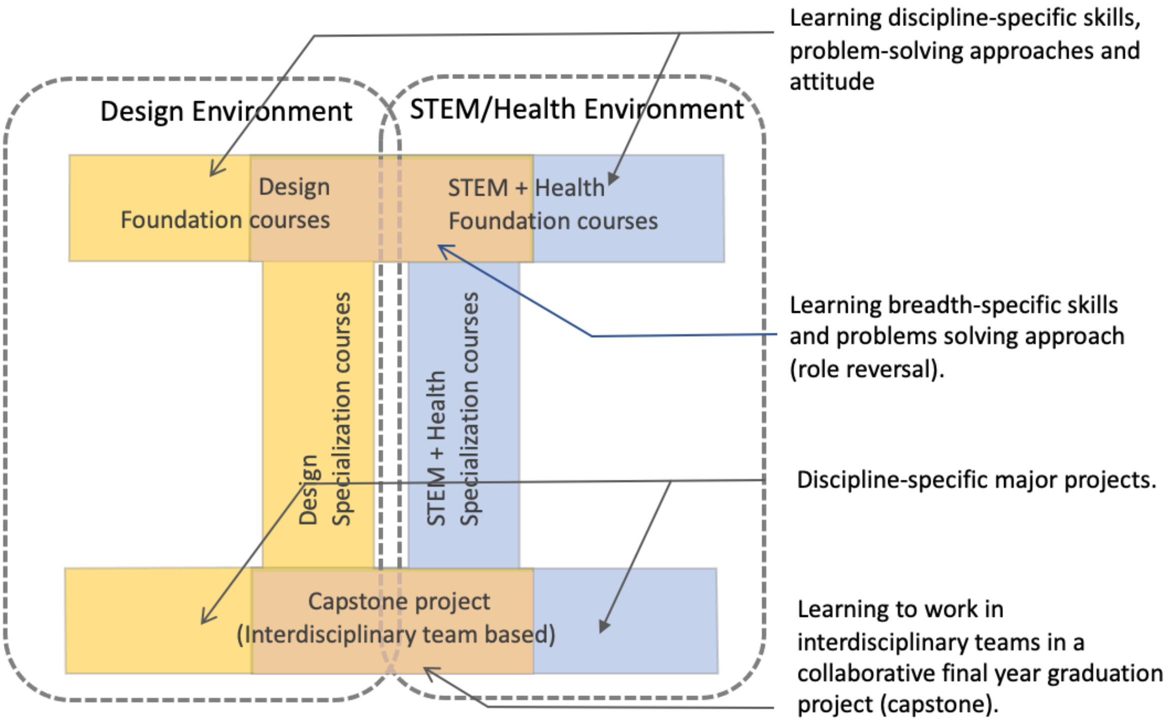

Figure 2: Possible plan for integrated courses – STEM to STEMHD

Figure 2 illustrates an approach that we put in place based on our early experimentation with a three-year Bachelor of Design and Bachelor of Information Technology degrees as well as Master of Science in Health Technology (MS-HT). The overall journey will go through the following milestones:

1. Learning discipline-specific skills, problem-solving approaches and attitude.
2. Learning breadth-specific skills and problems solving approach. Learning how to apply breadth-specific problem-solving approaches and attitude (role reversal). For example, IT student take foundations courses in design (Design thinking, Visualization and prototyping, Introduction to interaction design, etc.)
3. Learning to work in interdisciplinary teams in a collaborative final year graduation project (capstone). For example, IT students take supervised group projects – where groups of students will work with either student team member from design discipline or work with supervisor from design discipline. MS-HT students complete a capstone that is sponsored by an industry, community, or faculty partner.

Discussion

The pedagogical approach we are currently working with is intended to give students enough time to inculcate professional cultural attitudes through situated learning. However, as Nelson and Stolterman (2014, p. 33) noted:

> *"If a designer chooses a scientific approach, the whole design process will have strong similarities to a research process. This will limit or eliminate not only what is considered to be the preconditions of design, but also what is possible, what is needed, what is*

desired, and what the eventual outcome will be. It will no longer be a design process." (Nelson & Stolterman, 2014, p. 33)

The intention is not to turn a designer into a scientist or vice-versa. It is about having the depth of awareness to appreciate alternative approaches to problem-solving as against – tolerating the existence of alternative ways of problem-solving.

To validate our proposed pedagogical approach, we are offering a set of foundational design courses to Bachelor of Information technology students to help them learn breadth specific skills and problem-solving methods. In addition, offer few capstone projects for final year students to immerse them into interdisciplinary teamwork experience. In this instance, the capstone project problems are framed by the supervisors. Each team comprises two to three students under one to two supervisors. All teams should have an embedded designer who is either a student or a supervisor. The student feedback from the past two semesters showed us that this experience widened their outlook on solving complex problems. The following quotes are from the feedback of our current student group.

"... This unique opportunity to have sponsors from two separate disciplines has been greatly beneficial to the overall project. Dr Raghu provides guidance in terms of the design methodology of the system and Dr Masoud handles the technical aspects required to bring the project to fruition. They have made this project an absolute pleasure as they provide consistent support and encourage me to explore new ideas. A multidisciplinary team is exceptionally constructive as it provides a broader perspective and allows us to expand our vision beyond a particular discipline/mindset. As the capstone project is designed to give students the skills to solve a real-world problem, a greater school of thought is mandatory to ensure the success of any project … Having capstone supervisors from different schools have helped us garner creative visual ideas in multiple perspectives and exposure to several types of design methodologies…"

We have been investigating our proposed pedagogical approach over the past three semesters. Meaning, we still have not seen its full impact as students who have done foundational design units will only enter final year capstone projects next year. In parallel, design students from Bachelor of Design taking foundational Information Technology courses will be ready to join the capstone projects as embedded designers.

Conclusion

Acknowledging that interdisciplinary teamwork is becoming the standard in the industry as the STEM and Health fields are increasingly integrating designers into their teams. This both presents a challenge and an opportunity for design, STEM and Health education and the industry. It is no longer enough to gain knowledge the traditional way without being a highly functioning team member in an interdisciplinary work environment.

Designers are often the most equipped to humanise technology by integrating the supra-functional needs that complement the training of functional needs by engineers, scientists, and technologists. However, functioning in an interdisciplinary environment with conflicting approaches to problem-solving could be challenging. As we have observed in our own team experiences, conflicts may result from differences in working styles and behaviours. In this regard, the Belbin team performance model provided us with an insight into how a successful team is built on a balance of team and function roles. The team role is based on human aspects such as attitude and behaviours, and the functional role is necessary to fulfil a profession-based task. Most importantly, variations can be used constructively in an interdisciplinary team.

The traditional design and STEM curriculum effectively provide functional skills, and many recent integrated courses, including breadth subjects, help understand the importance of complementary skills. However, learning breadth skills alone does not provide soft skills to effectively function in interdisciplinary teams with diverse thinking and working styles.

This paper highlights the importance of team roles in an effective team member in an interdisciplinary work environment and presents a STEMHD pedagogical approach to provide these implicit skills through immersion. The outcome of the STEMHD pedagogical approach implemented in our case study over three semesters has shown promising results. Students' feedback from capstone projects further provides confidence in the success of STEMHD prelogical approach in addressing the growing demand for graduates trained to solve wicked problems the current economic reality expects.

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