Design Thinking in Healthcare Education

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Isabella Hajduk, Annika Nordberg, and Eeva Rainio

4.1 A Brief History of Design Thinking in Education

The concept of Design Thinking originated in the 1960's to describe the collective problem-solving process that the professional (industrial) designers use when developing new products for consumers. Since then, it has also been integrated into higher education. Design Thinking is a widely used approach especially in business, marketing, and entrepreneurship education, but also in engineering, architecture, and other design areas. It has also recently, during the past 5 years (also based on authors' own observations), started to become an increasingly important pedagogical tool in the education of health professionals [1–3].

We have collected representative examples of how Design Thinking is used or taught in health education around the world, as shown in Table 4.1 at the end of the chapter. The table does not aim to be a complete listing, but rather gives inspiration for further reading. For more examples, we also recommend the following recent review articles to readers. Sandars and Goh offer recommendations, how to efficiently use Design Thinking in medical education. They have concluded that Design Thinking usually has two main uses: it has been used directly to design a new product, or the principles of Design Thinking have been taught to students with the help

I. Hajduk
The Centre for Innovative Medical Research, Sydney, NSW, Australia
e-mail: isabella.hajduk@cimrglobal.com

A. Nordberg
Department of Nursing Science, University of Turku, Turku, Finland

E. Rainio (✉)
Faculty of Medicine, University of Turku, Turku, Finland
e-mail: eeva.rainio@utu.fi

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Table 4.1 Examples of how Design Thinking is used in health education

How was Design Thinking used?	References
Curriculum and course development	
Design Thinking was used in curriculum development: Since 2015 at Harvard Medical School the students have participated in curriculum work. They are, after all, the end users of the "product", which is the course curriculum	Anderson, J., Calahan, C.F. & Gooding, H. (2017): Applying design thinking to curriculum reform. *Academic Medicine* 92(4), 427
Design Thinking process was used to create a course Design Thinking for Public Good for public health students at the University of North Carolina at Chapel Hill	Skywark, E. R., Chen, E., & Jagannathan, V. (2021). Using the design thinking process to co-create a new, interdisciplinary design thinking course to train 21st century graduate students. *Frontiers in Public Health*, *9*
A full-day Design Thinking retreat to rethink the needs for continuing professional education with emergency medicine stakeholders	Chorley, A., Azzam, K., & Chan, T. M. (2020). Redesigning continuing professional development: Harnessing design thinking to go from needs assessment to mandate. *Perspectives on Medical Education*, 1–6
Design Thinking process was used in a 2-day workshop for health profession educators to develop recommendations how to evaluate the interprofessional health education	Cahn, P. S., Bzowyckyj, A., Collins, L., Dow, A., Goodell, K., Johnson, A. F., ... & Zierler, B. K. (2016). A design thinking approach to evaluating interprofessional education. *Journal of Interprofessional Care*, 30(3), 378–380
Design Thinking was used to solve an educational problem: how to overcome challenges with rural placements of students in various health professions	Wolcott, M. D., McLaughlin, J. E., Hubbard, D. K., Williams, C. R., & Kiser, S. N. (2021). Using design thinking to explore rural experiential education barriers and opportunities. *Journal of Medical Education and Curricular Development*, 8, 2382120521992333
Clinical Experience program was improved at Sidney Kimmel Medical College in a 3-h Design Thinking sprint with the program stakeholders. As a result, changes were introduced, and significant improvement of student satisfaction achieved	Fish, A. M., Fields, J. M., Ziring, D., McCoy, G., Ostroff, P., & Hayden, G. (2022). Curriculum development by design thinking: Analyzing a program for social determinants of health screening by pre-clerkship medical students. *Journal of Medical Education and Curricular Development*, 9, 23821205221080701
A novel online educational resource, The Path to Patient-Centred Care was developed with the support of a Design Jam event	MacKinnon, K. R., Ross, L. E., Rojas Gualdron, D., & Ng, S. L. (2020). Teaching health professionals how to tailor gender-affirming medicine protocols: a design thinking project. *Perspectives on Medical Education*, 9(5), 324–328

Table 4.1 (continued)

How was Design Thinking used?	References
Nursing education/interprofessional education in nursing	
Transdisciplinary course to engineering, nursing, and pre-professional health students was organized to introduce them to novel technologies and innovate solutions for community health problems. The course utilized MakerSpace open learning environment for prototyping. Special emphasis was on increasing understanding about ethical implications related to novel technologies	Lewis, E. J., Ludwig, P. M., Nagel, J., & Ames, A. (2019). Student ethical reasoning confidence pre/post an innovative makerspace course: A survey of ethical reasoning. *Nurse Education Today*, 75, 75–79
Presents a pilot of an innovation and Design Thinking workshop for nursing and sustainable peacebuilding students with the help of University Entrepreneurship Center at the Midwestern University's College of Nursing. The aim was to expose students to Design Thinking and teach them to use creativity and innovation	Holt, J. M., Talsma, A., Woehrle, L. M., Klingbeil, C., & Avdeev, I. Fostering innovation and design thinking in graduate programs. *Nurse Educator*, 10–1097
The article provides insights how the nursing faculty at the University of Alabama at Birmingham has used Design Thinking in introducing nursing research to undergraduate students. They discuss the Design Thinking benefits reflected in student experiences, including understanding the empathy in healthcare and future potential of understanding the Design Thinking process	Wingo, N., Jones, C. R., Pittman, B. R., Purter, T., Russell, M., Brown, J., & Ladores, S. (2020). Applying design thinking in health care: Reflections of nursing honors program students. *Creative Nursing*, 26(3), 169–174
Gives an example of interdisciplinary healthcare design jam event on the theme of innovative thinking to support LGBTQI2S Health and Wellness. In addition, the authors continued the development of an online education tool kit by partnering with nurse researchers who develop simulation games for nurses	Ziegler, E., Carroll, B., & Shortall, C. (2020). Design Thinking in nursing education to improve care for lesbian, gay, bisexual, transgender, queer, intersex and two-spirit people. *Creative Nursing*, 26(2), 118–124
Nursing students in South Korea were taught patient-centered care (PCC) with the help of 5-step Design Thinking process, 2 h each. After the course they self-evaluated their views on supporting patient individuality and on maintaining patient individuality while providing care. Results showed that student understanding about PCC increased during the program	Park, M., Giap, T. T. T., Jang, I., Jeong, M., & Kim, J. (2022, January). Listening to patients' voices: Applying the design-thinking method for teaching person-centered care to nursing students. In *Nursing Forum* (Vol. 57, no. 1, pp. 9–17)

(continued)

Table 4.1 (continued)

How was Design Thinking used?	References
Interprofessional education in other health disciplines	
Paper describes a use of Design Thinking process in an abridged hackathon workshop to promote interprofessional and inter-clinic collaboration on student-run clinics, as well as encourage workshop participants to design clinic practice improvements	Chen, K., Kruger, J., McCarther, N., & Meah, Y. (2020). Interprofessional, learner-driven collaboration for innovative solutions to healthcare delivery in student-run clinics. *Journal of Interprofessional Care*, 34(1), 137–139
Design Thinking principles were utilized in designing a shift handoff software as an interprofessional collaborative effort of medical informatics program and school of architecture and design	Lesselroth, B., Park, H., Duncan, H. M. A., Thompson, G., & Yarnall, R. (2021). Designing shift handoff software: Clinical learners and design students collaborate using the "design thinking" process. *Studies in Health Technology and Informatics*, 281, 974–978
This paper gives an example of Design Thinking Community Medicine workshop to teach about health-related social needs and to practice designing person-centered solutions for medical and physician assistant students	Lesselroth, B., Park, H., Monkman, H., Ijams, S., Yarnall, R., Kollaja, L., & Dennis, S. (2021). Student academy: A pilot design thinking workshop to teach community medicine. In context sensitive health informatics: The role of informatics in global pandemics (pp. 79–83). IOS Press.
Stanford University d.school offered Medical Device Design workshops to multidisciplinary team of undergraduate and graduate students: engineering, design, medicine, business, law, humanities, education, and earth sciences. They compared the experiential and observational learning during the first two phases of Design Thinking: understanding and defining the problems	Sherman, J., Lee, H. C., Weiss, M. E., & Kristensen-Cabrera, A. (2018). Medical device design education: identifying problems through observation and hands-on training. *Design and technology education: An International Journal,* 23(2), 154
Medical education	
3-day Innovation and Design Thinking course was piloted as a mandatory course in Singapore, aiming to give the medical students an overview of healthcare innovation, let them create their own solutions in design sprint, and practice pitching	Chen, P. P. Y., & Chou, A. C. C. (2021). Teaching health care innovation to medical students. *The Clinical Teacher*, 18(3), 285–289
University of Virginia offers Design Thinking course for first-year medical students. During this course, which lasts 1 year, the students will develop new services and solutions for patient work. This module had a clearly positive impact on their learning throughout the rest of their studies	Trowbridge, M., Chen, D. & Gregor, A. 2018: Teaching design thinking to medical students. *Medical Education* 52, 1199–1200

Table 4.1 (continued)

How was Design Thinking used?	References
In 2017 AMEE, an event called #ElsevierHacks utilizing Design Thinking methodology was carried out with students. It lasted 48 h, and together with software developers and designers the students generated new tools, such as mobile phone apps, to help with challenges in medical education. The participating teams also received support from marketing and technology specialists, as well as from medical educators Authors stated that Design Thinking gives excellent lifelong learning skills, which assist with teamwork and tolerating uncertainty, two very basic characteristics common to all healthcare professions	Badwan, B., Bothara, R., Latijnhouwers, M., Smithies, A. & Sandars, J. 2018: The importance of design thinking in medical education. *Medical Teacher* 40(4), 425–426
Design Thinking methodology has also turned out to be useful in trainings, where students solve complex ethical issues. This paper describes a Design Thinking workshop to propose better alternatives for liver transplant allocation system in US	Marcus, D., Simone, A., & Block, L. (2020). Design thinking in medical ethics education. *Journal of Medical Ethics*, 46(4), 282–284
Online transition examples from COVID-19 pandemic	
Description of teaching methods and learning outcomes from a novel course for American biomedical engineering and natural sciences students who participated on study-abroad activities in both US and Portugal. Aim was to teach how culture impacts on healthcare delivery and use of technologies The course went through a transition from study-abroad to study-online during COVID-19, and changes were reported in this article	Ferreira, M. F., Savoy, J. N., & Markey, M. K. (2020). Teaching cross-cultural design thinking for healthcare. *The Breast*, 50, 1–10 Lewis, M. M., & Markey, M. K. (2021). From study-abroad to study-at-home: teaching cross-cultural design thinking during COVID-19. *Biomedical Engineering Education*, 1(1), 121–125
University of Pennsylvania School of Nursing transitioned their hands-on community service course Innovations in Health: Foundations of Design Thinking, to online course and report the course changes and outcomes	Karwat, A., Richmond, T. S., & Leary, M. (2021). Transition of a collaborative in-person health care innovation course to online learning. *Journal of Nursing Education*, 60(5), 298–300

of a project where the participants develop a new product [4]. The nature of a new product can vary from curriculum reforms to medical applications. In their commentary, Madson summarizes the operationalization of current understandings of Design Thinking in medical education. They introduce different initiatives to incorporate Design Thinking into the curriculum [5]. Madson divides them into education programs, courses, workshops, and hackathons, from more extensive modules to short training events. Inspired by these reviews, the examples in the table are divided according to the use of Design Thinking in curriculum/content development or in educational courses/trainings. In addition, the references are grouped based on the field of education.

4.2 About the Chapter's Authors

Isabella, Eeva, and Annika all come from science/medical backgrounds, where Isabella is a molecular microbiologist, Eeva is a geneticist, and Annika is a nursing scientist. Throughout their academic careers, they each have had the opportunity to contribute to the teaching and learning side of tertiary education.

During her PhD candidature at the University of Technology Sydney (UTS) in Australia, Isabella was given an opportunity to participate in an international training program in the area of biomedical innovation and entrepreneurship (BIE), run by Professor Michael Wallach. The 2-week intense program takes a Design Thinking approach, where students are tasked with defining a health or medical problem and ideating and pitching an innovative and novel solution. Students are supported with relevant education and expert-mentoring throughout the program to help shape their ideas into feasible solutions. The BIE course was later adapted into a Master's core subject, called Innovation, Entrepreneurship, and Commercialization (IEC). Isabella joined Professor Wallach in teaching IEC in 2016, and since took an active role in further elevating the IEC subject into a fun, educational subject marrying biomedical sciences and Design Thinking.

Eeva was first introduced to the Design Thinking approach on a career course and fell in love with the approach. After visiting Stanford d.school in 2019, she was convinced that the Faculty of Medicine at the University of Turku needs to learn more about Design Thinking. Eeva's final project during her pedagogics studies in 2020 was a short Design Thinking course for medical students to assist them with their personal study plans. She was also the brains behind a new Design Thinking course concept called GREAT. She wrote a successful grant to Nordic Council of Ministers, which helped the Faculty of Medicine to organize its first multidisciplinary health and nursing-focused Design Thinking course, Design Future Health, or GREAT.

Annika is a public health nurse, whose passion has always been in the improvement of patients and end users experience. She has a shiny new Master's degree diploma in Health Sciences, graduated from the University of Turku. Annika has had experiences in design thinking courses on both sides: she took part in the international version of the BIE course in 2020 as a student and has also worked as a project coordinator and teacher in the above-mentioned GREAT, as well as in a very similar course called D.pop, which is intended for the healthcare professionals.

This chapter is posed to be a guide and insight from teachers for teachers, for the integration of Design Thinking into STEM (Science, Technology, Engineering, Mathematics) education with some tools and exercises to be used by teachers. It will be described predominantly in context of the IEC course at UTS and the BIE course, and the lessons learned by Isabella, with additional insight from Eeva and Annika and their experiences in the GREAT Course. This chapter is anecdotal in nature; however, since its inception in 2012, there have been many iterations and improvements to the IEC course, with much feedback from the students and many lessons learned, which the authors have shared here.

4.3 About Our Courses

The IEC course is run over 12 weeks in a connected progressive manner and delivered in three progressive themes: team building, science, and business. The BIE course is much like the IEC course; however, it is delivered in a 2-week intensive mode. The students are posed with a health or medical problem, which over the course of the subject, they need to break down and develop for it a hypothetical but feasible solution. The problems put forward are ones from academics at the university in their area of research. These academics participate several times throughout the subject to provide mentorship and feedback, ensuring that the ideas being developed are scientifically feasible and uphold established dogmas of the topic. This mentorship is one of the key factors for successful learning and engagement for the students, which will be discussed more later.

Design Future Health or GREAT was a combination of a 4-week course held online and a week-long intensive course, intended for both MSc and PhD students representing multiple fields including nursing science, medicine, biomedicine, pharmacy, information science, health technology, and economics. The student groups received real-life challenges collected from healthcare services, and over the courses they solved them following the Design Thinking process. The course aimed to equip the participants with a new way of creative thinking about complex healthcare problems and also increase their entrepreneurial mindset.

4.3.1 How Best to Deliver a Design Thinking Course?

A key lesson from teaching these courses is that nothing is certain, and we need to take on uncertainty and learn to pivot. The COVID-19 pandemic was undoubtedly an event of uncertainty and we had to quickly adapt and pivot our teaching approaches to different learning modes: in-person learning, solely online, or a hybrid approach. The hybrid approach can be interpreted in two ways: a mixed delivery approach where lectures are delivered online and workshops or other activities are delivered in-person; or where the classes are delivered in-person; however, the students can join either in-person or online. Table 4.2 provides an overview of the strengths and weaknesses that we have perceived firsthand from running our courses in different modes. Regarding hybrid, the strengths and weaknesses posed are in reference to the latter interpretation of hybrid delivery defined above.

While online has its clear advantages, social interaction is one of the most important factors for learning (especially Design Thinking) that is rooted in human experience. Isabella has run both programs, the BIE course and the IEC subject in each of the three modes. In her experience, Isabella believes in-person learning is the most effective mode of learning—both for the students and for the teachers. The students can establish a deeper connection with each other, while the teachers can directly sense when groups or students need help.

Running the programs online decreases the personal responsibility for engagement in the work. For example, in the BIE course, students will partake often from

Table 4.2 An overview of the strengths and weaknesses of different learning modes

	Face-to-face (classroom)	Online course	Hybrid
Strengths	• Allows for more extensive collaboration • Conducive to teamwork • Social interaction and network • Personalities can be expressed more freely • Allows for innovative group dynamics • Easy communication • Conducive to pre- and post-class discussion • Allows for coffee breaks, leading to further social interactions • More flexible content delivery • Teacher can help to motivate & encourage	• Flexible time frame (schedule) • Allows for attendance worldwide • Cost-effective for the organisers • Affordable for the attendees • Comfortable and convenient • Time efficient as there is no need to travel or set up classrooms • Easy access to digital learning materials	• Flexibility for all students, notably international students that are unable to reach the place of education for different reasons • Teachers do not need to repeat content for absentees because they are able to join the class online if they are sick • Opens opportunity to include international speakers for the educational material • Can be beneficial for the empathising stage of Design Thinking
Weaknesses	• Requires a dedicated location and space to which all parties need to travel. • Strict time schedule • Higher cost • Greater organisation efforts • For the block mode, there is a greater time commitment as it requires students to travel away from their place of work for a set time with little chance of completing some of their own work outside of the course hours	• Requires technology experience • Heightened chance of technical problems • Difficulty in having meaningful interaction with students • Difficulty in networking with others • Limited communal synergies • Different personalities may be perceived differently • Limited verbal/non-verbal communication	• Difficult to facilitate groups that have both in-person and online students. Online students are often left out of the conversations • Presentation of learning material requires the teacher to be connected with in-person and online students. Questions and interactions with online students are often left secondary • Classroom needs to be set up for hybrid (speakers, microphones, etc.) • Need to try and group students by their attendance mode and avoid mixing online with in person – leads to difficulty in communication and group discussion within the class

their place of work. Because of this, they often will take breaks away from the course to attend to other work. This adds a significant level of difficulty for the teacher to ascertain when the students require assistance or are just not present at their computers for the course. Running the courses face-to-face allows the students to focus on their team and the course work more actively.

Another factor to consider is the duration of the programs. We have each run our program over different durations:

1. BIE course: 2-week intensive, running full time (Monday to Friday, 9–4 pm; delivered either in-person or online only).
2. Great Course: hybrid mode—4 weeks online once a week for lessons to learn the fundamentals of Design Thinking, plus online group work with a real healthcare-related problem. After this introductory 4 weeks, 1 week in-person intensive mode where the application of Design Thinking method can be deepened with a new complex healthcare problem.
3. IEC subject: 3 h per week over 12 weeks. This is time spent with the teacher and does not include the hours that students spend together outside of class or completing assessments—this would average to be an additional 3 h per week. Has been delivered in all modes (in-person, online only, and hybrid).

Each of the three durations we have run has their advantages and disadvantages; however, it ultimately comes down to the requirements of the institutions and availability of the students.

4.4 A Student's Journey Through Design Thinking

Over the many years of running the three programs, we have observed an interesting journey or transition that the students go through over the duration of the course. That is, their experience within the classroom and within themseleves parallels that of the journey through Design Thinking, going from problem to solution (Fig. 4.1). These three stages we have put forward as confusion, clarity, and completion: i) confusion: in who they are as an individual, how they can fit and contribute within

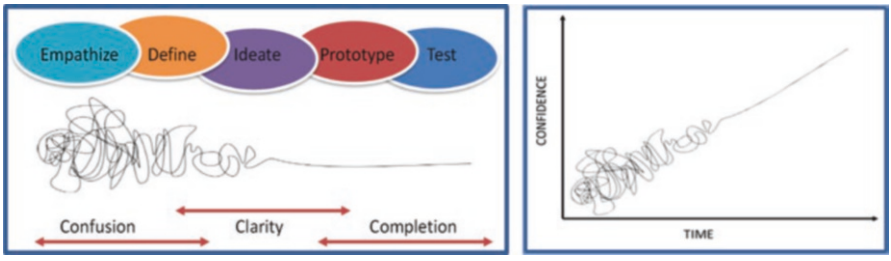


Fig. 4.1 Student's journey from confusion to completion and confidence during a typical Design Thinking course

a group setting, and their abilities in addressing complex and unfamiliar problems; ii) clarity: gaining confidence within themselves, in their creativity and contribution to the team, as well as their understanding of the problem and how to address it in a meaningful way; and iii) completion: the sense of achievement when they have worked together and to their strengths to put forward a well-developed, well-tested, and feasible solution.

One of the most reoccurring points of feedback we receive from students after completing our programs is that it is completely different to anything else they have done throughout their educational journey. They perfectly reiterate the stages mentioned above, highlighting how confused they are at the beginning, but then feel rewarded at the end. This is because the Design Thinking experience can be a difficult one to adapt to as it is a different way to learn. It is therefore ultimately our mission as the teacher to instill confidence in the students and push them out of their comfort zones to achieve something they have not done before. This is ultimately essential for their own personal and professional growth, leading them to:

- Take more risks
- Ask questions
- Think critically
- Think outside the box
- Encourage a desire for lifelong learning
- Expand their thinking in generating ideas and seeing them through
- Improve their communication skills

All these factors ultimately culminate to better healthcare professionals. Employers are increasingly seeking individuals with a range of soft skills that can be deployed within teams and entire organizations, including creativity, adaptability, communication, management, and leadership skills [1]. But beyond this (especially in the field of healthcare) employers are seeking caring and nurturing individuals, capable of both seeing to the medical needs at hand as well as empathizing with the patient and their individual needs [6–8].

In the following sections, we will lead you through the process of Design Thinking in the context of the student experience (Confusion, Clarity, and Completion) to give you insight and tips on how to assist your students through the Design Thinking journey, as well as some tools and exercises that we have found most valuable in our courses that you can use in class to aid in their learning throughout the Design Thinking process. Each section will be described, where relevant, in context of their:

1. Internal motivation—how they may be feeling on an individual scale
2. External standings—how they work together as a group
3. Project development—the work they are undertaking for the course

4.4.1 Confusion

The start of a Design Thinking course is undoubtedly the most confusing for the students. They must: i) [1] pivot their usual modes of learning to that of creative and innovative thinking required for Design Thinking, ii) [2] adapt to teamwork and find a balance among the members and their (very likely) different personalities, and iii) [3] personally find their value in the team and confidence in the work. It is therefore at this point that the role of the teacher is most important, to juggle these three factors and build the foundations for the students going forward.

4.4.1.1 Internal Motivation

To be able to effectively contribute, the students need to understand who they are and what they can bring to the table within their teams. The first hurdle for the teacher is to help the student understand who they are as a learner and to bring about their motivation and creativity for the tasks at hand.

Student motivation is essential for any Design Thinking process to succeed. We can argue that typically the nature of the problems we attempt to solve with the help of Design Thinking, is usually such that students will perceive them as motivating. Students are working with tangible goals trying to improve the quality of people's life, create novel innovations, or provide practical solutions for everyday healthcare work. It is easy to understand why improving health is important and that we all should have some understanding about such type of problem solving. Moreover, the human-centered approach is easily understood by the students when they perform the empathizing step. Students feel engaged because they have adopted the social, ethical, and economical values into personal interest and are willingly, and happily, acting to reach the goals of the project and produce useful outcomes.

This finding about student motivation can be examined from the theoretical perspective. It is supported by the self-determination theory, developed by Ryan and Deci [9]. It is one of the classical approaches to human motivation and personality, identifying the needs for competence, relatedness, and autonomy as basic needs to self-motivation. The theory divides different motivation types into intrinsic and extrinsic. Intrinsic motivation refers to activity, which is done because the activity itself is satisfying. The term extrinsic motivation is indicating activities which are performed to reach certain outcomes, and the extrinsic motivation can be further divided to subtypes. At one end of the extrinsic motivation spectrum, we have students performing tasks because they simply want to avoid punishments and get rewards, whereas at the other end of the spectrum, extrinsic motivation is very similar to intrinsic motivation. During the typical Design Thinking project, the students may accept the project tasks as personally important, or experience even stronger self-determination and have integrated the extrinsic values as their own values and needs.

Motivation also fuels creativity. Whether creativity can or cannot be taught remains debated, but teachers can support the learners to enhance and develop their creative thinking. Baer has summarized his and others' observations, how extrinsic

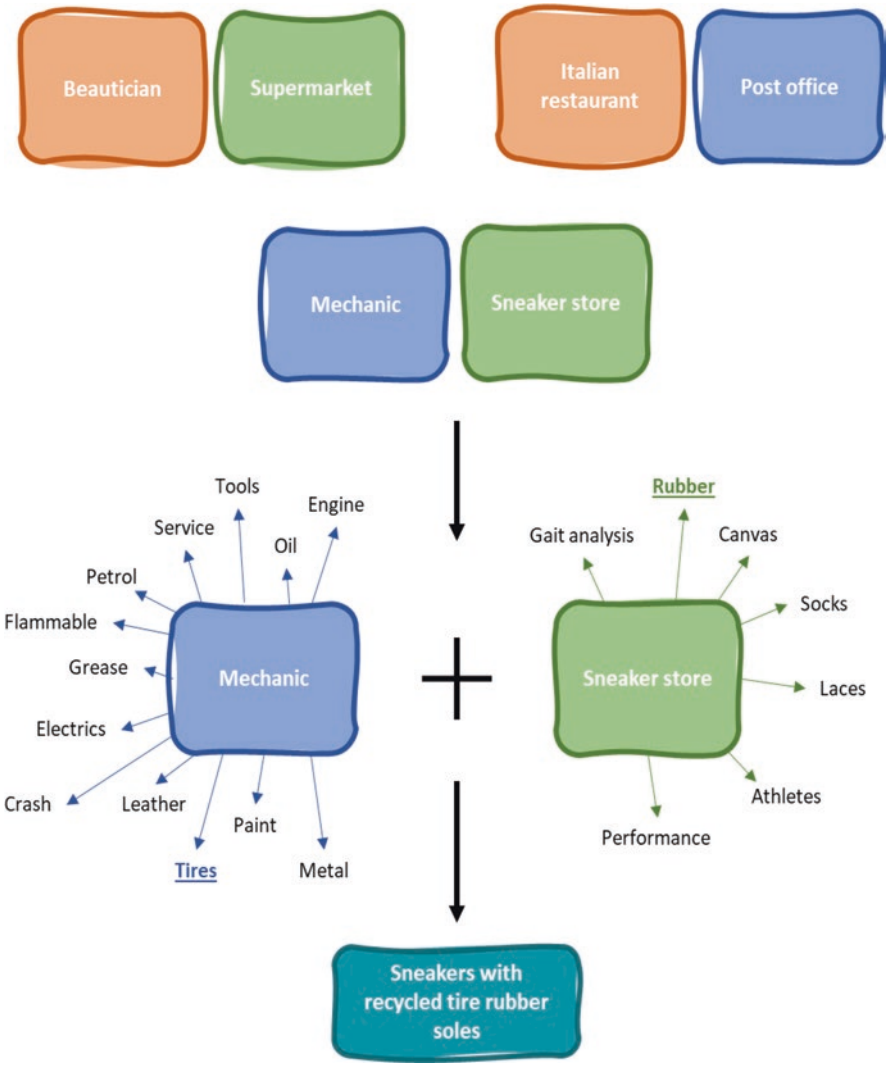


Fig. 4.2 Random Jamming involves creating a new idea from the merging of two existing ideas. In our Random Jamming exercises, the students within their group put forward either a common service or shopfront and creatively think of new products or services incorporating both. In the example provided, there are three students that have put forward two ideas each (orange, green, and blue sticky notes). The ideas put forward are mixed and randomly paired off as shown by the mixed colors. It is key that students think (or mind map) beyond the obvious for each sticky note, to push themselves into the creative space of the exercise

rewards or evaluations may negatively influence creativity, because such constraints lower intrinsic motivation [10].

A popular activity that we have implemented to kickstart student creativity is called Random Jamming (Fig. 4.2). We usually start the course with this activity as a means of an ice breaker but can be played at any point throughout the course,

for example, to kickstart the ideation phase of Design Thinking. A benefit to such ice breaker activities at the start of a course is that it can also aid the teacher in the formation of groups. Such activities not only allow the students to begin building their confidence amongst their peers, but it also allows the teacher to both interact with the students to see who they are and to see how they interact with each other.

One thing to consider for student internal motivation is to understand what type of personality they possess so that they further understand themselves and their potential role within a group setting. Miller and others have used the Myers-Briggs type inventory in understanding individual personalities; and how they play into group dynamics and in the fostering of group performance, harmony, and student satisfaction (discussed further in the next section) [11]. Similarly, Isabella has implemented the Myer-Briggs personality test to instigate an individual reflection assessment for two purposes: i) to allow the students to gain new insights about themselves and what role they are best suited to play within a group; and ii) to aid the teacher in profiling the different personalities and creating dynamic groups, where possible. The journey through IEC is presented to students as the formation of a start-up. Therefore, in IEC, different Myer-Brigg personalities have been matched with the different roles commonly found within a start-up, such as CEO, CTO, COO, and so on (Table 4.3). The students can identify their role within their group and this gives them a sense of responsibility to play to.

Table 4.3 Potential Myers-Briggs type inventory (MBTI) personalities to suit common roles found in start-ups

Position	Role	Attributes	Potential MBTI
CEO: Chief Executive Officer	A jack-of-all-trades, the leader of the startup, both the team and the work at hand	Natural leader and decision maker, team player, high energy, resilient	ENTJ or ESTJ
COO: Chief Operations Officer	Works closely with the CEO to oversee the operation of the startup.	Intelligent and capable of analytical thinking and creativity, trustworthy	ISFJ or INFJ
CFO: Chief Financial Officer	The money person, needs to have a deep understanding of startup's financial capabilities through all stages	Systematic and structured habits, observant and analytical mind, efficient work ethic, responsible	INTP, ISTJ or ISTP
CTO: Chief Technology Officer	Lead technical person, focuses on the development of the technology	Ambitious, problem-solver, critical thinker, strategic	INTP or INTJ
CMO: Chief Marketing Officer	Creator of the company image. Needs to have good understanding of your market and how the product/service fits in.	Curious, observant, energetic and enthusiastic, excellent communicator, knows how to relax, very popular and friendly, artistic and innovative	ENFJ, ENTJ or ENTP
CPO: Chief Product Officer	The bridge between CTO and CMO: marries the vision of the technology being developed together with the needs of the market.		
CSO: Chief Sales Officer	The hustler of the team, turns the product/service into a flowing profit.	Confident, persistent, creative, self-motivated, enthusiastic, high energy, thrive on interaction	ESFP, ESFJ, ESTJ or ENTJ

4.4.1.2 External Standings

We will state right off the bat, that we recommend that the teacher form the student groups, instead of allowing to group themselves. Leaving this decision to the students, they will always pair off with known fellow students. Although this familiarity will benefit such individuals to boost their confidence to be creative by entering an already familiar environment, this will undoubtedly hinder the individuals that do not have already existing relationships. The teacher creating the teams allows an even playing field for all students, one in which they can grow in confidence together.

So how can we make sure the group dynamics is optimal, and everyone participates in joint activities? We have experience in facilitating international Design Thinking courses with participants from different disciplines. In an international teaching setting, it is useful to make sure that as many nationalities as possible are represented in each group. This gives the cross-cultural aspect to group work, which helps the group to understand the variety of opinions and the multiplicity of different viewpoints. Beyond this, it is important to also consider diversifying regarding gender, age, education level, study discipline, and personality (if feasible, discussed later). Such diversifications are valuable for the whole learning process, and in Design Thinking especially in the empathizing step when the students are using all the possible skills to listen to the user and trying to understand the nature of the problem. The outcome with the group of mixed nationalities may be fruitful; the end result of the Design Thinking process can be a totally surprising solution. Moreover, the cross-cultural learning experience will give a lifelong toolkit to the students for international working environments.

We have also found that the interprofessional or multidisciplinary group vitally supports the success of the Design Thinking process. For example, a design team consisting of nurses only may face problems when they try to visualize their proposed solutions or build prototypes. Students with science and especially with an engineering background are more familiar with turning their ideas into practical models to test how they function. However, in turn, they may be far less accustomed to listening to the needs of their target group. In GREAT course we also learned that students from business school can also easily help in evaluating the market value of the solutions, and those studying information technology can also shine if the proposed solution is, let's say, a mobile application. Therefore, we recommend making the groups as dynamic as possible based on the above criteria, and where feasible, target the courses for the students of a minimum of two different study programs.

As mentioned in the previous section, a mix of personalities can be beneficial to group dynamics and performance. Learning style theory gives a central role to the Thinking-Feeling and Intuition-Sensing. According to Miller and others, diversity on these two central dimensions benefits most groups [11]. Judging-Perceiving and Introversion-Extroversion dimensions affect the group harmony. They have noticed that similarities in these areas influenced student satisfaction with the course. It is easier to work in the group if the members play by the same rules. However, conflicts arising from diversity of these dimensions can induce intelligent debates and innovations which lead to enhanced group performance.

Design Thinking process should always be performed as a team effort. But how many students to a group? This may appear as a trivial question, but is in fact an important consideration for a Design Thinking course. We have found that three to four students per group is an effective number. Too few and the students may feel overwhelmed with the workload, too many and you will have mixed student contribution which will likely lead to group conflicts. Beyond this, it stimulates interprofessional and multidisciplinary collaboration, provides valuable group support, and develops creative thinking, just to mention a few obvious benefits. But the group learning also has a strong pedagogical dimension.

The active learning methods used in facilitating a Design Thinking team are often based on cooperative learning. Cooperative learning is not simply just group work, but it is defined as an instructional method, where students work together in groups to maximize their learning to reach common goals under the following conditions:

1. Positive interdependence
2. Individual accountability
3. Promotive interaction
4. Social skills
5. Group processing

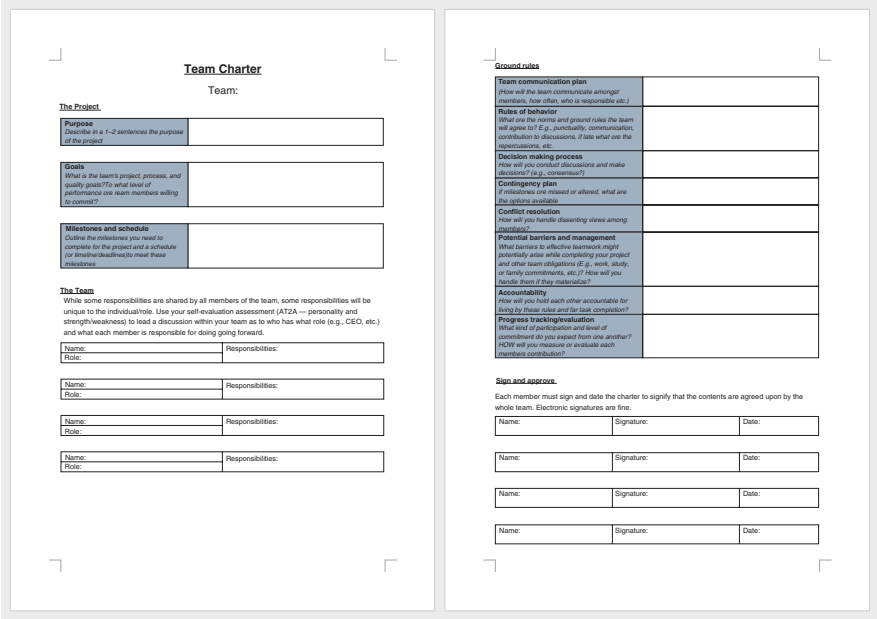
This is the Johnson & Johnson model of cooperative learning [12–14], and it serves as a foundation for many active learning methods, such as problem-based learning, team-based learning, collaborative learning, and peer-assisted learning.

Positive interdependence simply means that the group members understand that they can only succeed if all the others succeed. They are linked to each other; if one fails the whole group sinks.

This interdependence naturally creates individual accountability: everyone must do their share for the group to reach the set goals. Each group member must also be able to understand all the details of the project. For promotive interaction to occur, students must provide constructive feedback, teach, and encourage each other. In order to do so, and to support the development of their social skills, they can be taught teamwork skills including leadership, decision making, and communications skills.

Instructors of the group can facilitate the learning situation to fulfill the above-mentioned conditions of cooperative learning. Felder and Brent offer several suggestions for different techniques in their review [15]. Facilitator also has a significant role in forming the team, because group learning creates its own challenges.

However sometimes, despite the best efforts of the teacher to create the most ideal groups, conflicts within groups may still arise. To mitigate potential group conflicts and to ensure that all team members understand their roles and responsibilities, team rules and policies should be agreed at the beginning of the project, and teams should be encouraged to regularly discuss and evaluate their performance and make changes if needed. To aid in this, we have previously employed the use of team charters within our courses (Fig. 4.3). Team charters are developed at the onset



Team Charter

Team:

The Project

Purpose *Describe in a 1–2 sentences the purpose of the project*	
Goals *What is the team's project, process, and quality goals?To what level of performance ore team members willing to commit?*	
Milestones and schedule *Outline the milestones you need to complete for the project and a schedule (or timeline/deadlines)to meet these milestones*	

The Team

While some responsibilities are shared by all members of the team, some responsibilities will be unique to the individual/role. Use your self-evaluation assessment (AT2A — personality and strength/weakness) to lead a discussion within your team as to who has what role (e.g., CEO, etc.) and what each member is responsible for doing going forward.

Name: Role:	Responsibilities:
Name: Role:	Responsibilities:
Name: Role:	Responsibilities:
Name: Role:	Responsibilities:

Ground rules

Team communication plan *(How will the team communicate amongst members, how often, who is responsible etc.)*	
Rules of behavior *What are the norms and ground rules the team will agree to? E.g., punctuality, communication, contribution to discussions, if late what are the repercussions, etc.*	
Decision making process *How will you conduct discussions and make decisions? (e.g., consensus?)*	
Contingency plan *If milestones are missed or altered, what are the options available*	
Conflict resolution *How will you handle dissenting views among members?*	
Potential barriers and management *What barriers to effective teamwork might potentially arise while completing your project and other team obligations (E.g., work, study, or family commitments, etc.)? How will you handle them if they materialize?*	
Accountability *How will you hold each other accountable for living by these rules and for task completion?*	
Progress tracking/evaluation *What kind of participation and level of commitment do you expect from one another? HOW will you measure or evaluate each members contribution?*	

Sign and approve

Each member must sign and date the charter to signify that the contents are agreed upon by the whole team. Electronic signatures are fine.

Name:	Signature:	Date:
Name:	Signature:	Date:
Name:	Signature:	Date:
Name:	Signature:	Date:

Fig. 4.3 An example template for a group chapter for students to fill in, abide by, and reflect on throughout their group work

of group formation and create a "contract" among the members to which they need to abide, and which the teachers can use to reference individual requirements later in the course, when the students' motivations might begin to slide. This idea is supported by Felder and Brent who suggest establishing team policies as a means of developing teamwork skills and dealing with uncooperative members [15].

4.4.1.3 Project Level

For participants with a background in natural science, the Design Thinking approach can certainly be very puzzling at first. Science/medicine students are not necessarily accustomed to using the maker-type of creativity in problem solving. According to Owen, "makers", or "designers", demonstrate their creativity through invention, whereas scientists are "finders", who work with discoveries, trying to find explanations [16]. Their brain is wired to look for the one and only correct answer, and in Design Thinking there is no right or wrong answer, but an almost indefinite number of better—or worse—solutions from which the "designer" will choose the best for the given situation.

To a certain extent this compares to basic scientific hypothesis testing, but usually hypotheses are built in a way that they can be proven to be simply right or wrong. Whereas in Design Thinking, the aim is to iteratively improve and prototype the initial idea toward the best possible solution. For a teacher this fundamental difference is important to understand because the teacher's role is to support the learners to endure the initial overwhelming uncertainty.

But uncertainty is good. We need to encourage students to lean into this uncertainty because this uncertainty allows for curiosity and creativity, for asking questions, and asking why. This is essential at the early stages of the Design Thinking process so that the true problem to be solved is identified. Students will often argue that they do not know enough about a topic to understand it. Our response to this is always "good!". They will likely already have some basic science or medical foundation to guide them; however, their "naivety" is advantageous for observing and analyzing a problem from a broader perspective and asking more and bigger questions. Once the questions are put forward, they can then dig for the answers to being an iterative process to gain a deeper understanding. By already starting with an in-depth understanding about a topic, they blind themselves to other opportunities and understandings of the problem and potential solutions.

We need to also ensure that ample time is spent on defining the problem. It is not a 20-min activity, but often a multi-class activity with research and discussion among team members and teachers. Our experience with both students and academics is that we have a natural tendency to jump into ideating solutions. If the problem is not properly defined, it will have a significant impact on the generation of solutions. This is especially vital in health-related problems, which are often multifaceted and complex. Without truly understanding the problem, how are we to know if we are solving the right problem? In IEC, the students are posed with a problem put forward by an academic in the field. These problems put forward are predominantly broader questions, which the students need to break down, for example, "current harbour pontoon designs are negatively impacting harbour biodiversity". If students take this problem at face value, they may fall upon a good idea, but are more likely to miss the mark and design a new pontoon that only partially solves the biodiversity issue, or not at all. Therefore, the main exercise that we employ is the "5 Whys" exercise, originally developed by founder of Toyota Industries, Sakichi Toyoda.

The 5 Whys exercise, as the name describes, is asking why to a bigger or superficial problem five times (although it does not always need to be strictly five times), until a root problem is established. The 5 Whys is a simplistic exercise in instruction. However, the 5 Whys, especially in health- or science-related problems, is not an easy activity to implement. Students will often just ask "why" to their previous statement, which may result in them looping back to a previous answer and not reaching the root problem. Instead, their "why" questions should integrate their previous answer to ensure that the why path progresses effectively. See Table 4.4 for an example of these two modes.

In healthcare, problems are often multifaceted. Encourage students to tackle their initial problem from different perspectives (for example, scientific, medical, general, economic, or environmental perspectives, etc.) to then form a "Why-tree" in which there are multiple root causes to an initial problem. Creating a Why-tree can be beneficial to put into context for the students the complexity of the initial problem and allow them to better focus on the one root problem, without trying to tackle them all. Figure 4.4 is an example of a Why-tree that we have put forward on the larger problem of hospitals being potentially hazardous places for staff. It is not a perfect Why-tree as it could have used the advice put forward above to reveal more

Table 4.4 A comparative example between a constructive versus less constructive 5 Whys activity to the complex problem of antimicrobial resistance. On the left, it is seen that a significant root cause to the rise of antimicrobial resistance is due to the lack of understanding of antibiotics and how they work, leading to mis- or over-use. By identifying this, students can then go on to ideate how they might help people understand this difficult topic, such as education programs or apps, ad campaigns, and so on. On the right, "why" is not asked in a constructive manner and so the concluding "root cause" is not in fact a root cause at all, but a symptom of antimicrobial resistance, and so no solutions can be effectively ideated

Constructive	Less constructive
Antimicrobial resistance–why is this a problem?	Antimicrobial resistance–why is this a problem?
Existing antibiotics not working	Existing antibiotics not working
Why are existing antibiotics not working?	Why is this a problem?
Antibiotics are overused	People have no way to help overcome their
Why are antibiotics overused?	infections
Doctors overprescribe antibiotics	Why is this a problem?
Why do doctors overprescribe antibiotics?	They could die.
Patients demand a solution to their infection	
regardless of the cause for the infection	
Why do they demand a solution despite the cause?	
Because they do not understand that antibiotics do not work on all infections.	

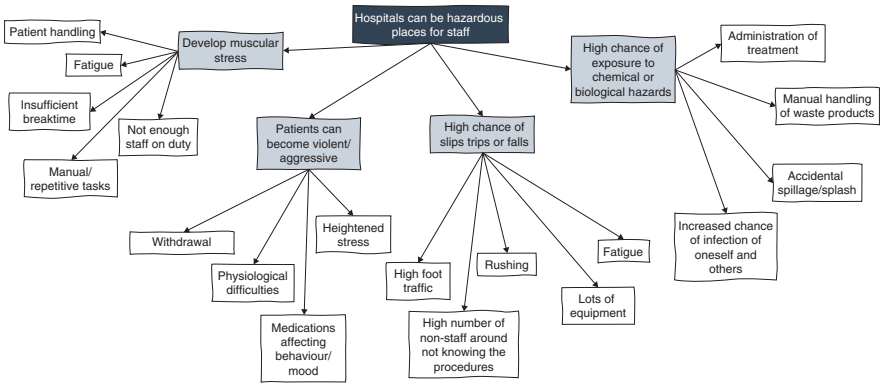


Fig. 4.4 Example of the start of a Why tree around the problem of hazards to staff in hospital settings

root causes, but there were nonetheless some interesting revelations that allowed for creative discussions and solutions. Each root could also be further elaborated on; however, we have kept it brief due to image size.

Empathy is a crucial step in the Design Thinking process, especially in healthcare. However, depending on the duration of the course, it can be difficult to implement, with limited or difficulty in accessing patients or individuals affected by the problem. If this is the case, then we strongly encourage some level of indirect modes of empathizing. This includes forums, discussion boards, or videos to gain as much

Fig. 4.5 Personas are a short profile of a person of interest to you, that you can use throughout the Design Thinking person. Personas go beyond that of general demographic descriptors, but also capture emotional and behavioral observation—both directly and indirectly related to the problem at hand. Personas can be based on a certain individual or can be an amalgamation of similar personalities which you have profiled to create a fictitious individual

information as possible and bring light to factors of the problem not illuminated during the problem-defining stages. Information gathered can then be used to create fictional personas representing key persons affected by the problem (Fig. 4.5). These personas can then be used and referred to throughout the duration of the course to gain clarity and feedback on whether the problems defined, and ideas formed are truly solving the problem at hand.

4.4.2 Clarity

As the students enter ideation and allow for continued iterations of defining, empathizing, and ideating; they gain confidence in their understanding of the problem and begin to transition from confusion to clarity. It is our role then to transition to facilitators of thinking, in which we do not give answers, but instead pose questions back to the students to push and expand their thinking.

4.4.2.1 Internal Motivation and External Standings

With a strong foundation of team building built at the start of the course, team dynamics need to be continuously developed and monitored throughout the subject. Without a strong foundation, progression through the subject is significantly hindered. It is therefore vital to allow students to reflect on both their own and their team members' contributions throughout the course to understand each person's value and any shortcomings that need to be addressed. Some tensions may be visible to the teacher by observation of team interactions during class; however, there may be underlying or hidden issues unknown to the teacher. Therefore, one online tool we have utilized in complement with the team charter is called SPARKplus—a peer evaluation tool where students reflect on their own and their peers' contributions in a quantitative manner (Fig. 4.6) [17].

We have implemented this tool after each assessment to gain an understanding of student contributions and to mitigate any conflicts or lack of contribution. Because this tool gives a quantitative output of individual contributions, we have used this tool to moderate student grades to ensure that those that contribute adequately to assessments are not hindered by students that do not.

4.4.2.2 Project Development

From our observations, the first step is having a well thought-out problem question which allows for both a sense of direction for the students' thinking and the best ideas to form. Phrasing the problem as a "how might we" question pushes you into the ideation mindset. Be sure to have the team spend some time on thinking of the statement in different ways and establish a few versions of the problem statement to allow for multiple rounds of ideation. They can do this by following loosely the statement formula: "How might we (verb) (root problem)?" Have the students play around with different verbs in the statement, and where possible, see if they can bring the problem-affected population into the statement to reiterate the empathetic factor of the problem. Some examples of ways to start the statements may include:

- How might we prevent …
- How might we reduce …
- How might we aid …
- How might we determine …
- How might we identify …
- How might we improve …

CONTRIBUTION TO PROCESS/OUTPUT

1. **Actively participated in activities, including class discussions and exercises, and activities outside of class organised by the team, including online communication, meetings, etc.**

Student	Almost never	Seldom	Sometime	Fairly often	Almost always
Name 1	1	2	3	4	5
Name 2	1	2	3	4	5
Name 3	1	2	3	4	5
Name 4	1	2	3	4	5

2. **Offered well-considered and innovative ideas and was receptive to the ideas and suggestions of other group members**

Student	Almost never	Seldom	Sometime	Fairly often	Almost always
Name 1	1	2	3	4	5
Name 2	1	2	3	4	5
Name 3	1	2	3	4	5
Name 4	1	2	3	4	5

3. **Contributed adequately to the overall organisation of the tasks and provided team members with required information and work within specified time-frames**

Student	Almost never	Seldom	Sometime	Fairly often	Almost always
Name 1	1	2	3	4	5
Name 2	1	2	3	4	5
Name 3	1	2	3	4	5
Name 4	1	2	3	4	5

Be reflective of each team member. Use your Team Charter as a prompt of what to reflect on. Did the team member abide by the charter that they signed? What areas specifically? (min 25-max 500 words)

Student	Reflection
Name 1	
Name 2	
Name 3	
Name 4	

Fig. 4.6 Example criteria used for collecting information on peer contributions throughout the course. Students assess themselves and their peers on a scale of 1–5. They also need to write a short reflection explaining their scoring

From the Why tree about hazards to staff in hospital settings, let's take the identified problem: "increased chances of infection to oneself and others". This can be further elaborated and phrased into several "How might we..." statements to aid in brainstorming, for example, "How might we protect nurses from infectious materials?", "How might we reduce the chance of staff infecting others?", or "How might we prevent staff from becoming infected?". Although they sound similar, these slight differences in phrasing the problem can ignite different ideas and solutions.

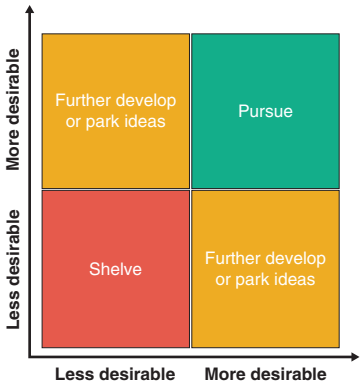
Once a problem question/statement is established, the ideation can begin. One of the keys to effective ideation at the early stages is to not sit and ruminate on an idea for too long. Orchestrate the initial brainstorming sessions in a lighting round style, in which the students are encouraged to come up with as many ideas as possible in a short amount of time (a few minutes per round). A fun and interesting way which we have run ideation in our courses is using an exercise commonly known as 6-3-5: 6 people, 3 ideas, and 5 rounds. However, because we aim to have groups of four, we have adapted the concept into an exercise we call "Quick Rounds" (Table 4.5).

Quick Rounds is beneficial in that it allows for:

- The generation of numerous ideas
- Limited overthinking idea generation on an equal scale. That is, shy or introverted individuals are able to put their ideas forward in an equal manner to those that are more confident
- Combination or snowballing of ideas

Table 4.5 Quick Rounds is a quick and fun activity to generate several ideas in a short time. It starts with putting forward the "How might we..." question to be thought about. Then the piece of paper is passed around to each team member for 2–3 min per person. You can either do it that there is one paper for the group to be passed around, or have a separate paper per person, so that there is four papers being passed around each time set. In this latter option, you can have all four papers have the same starting question which may go down different thought paths depending on the student starting the round, or you may have four different iterations of the "How might we..." question to provoke different ideas

How might we:			
	Idea 1	**Idea 2**	**Idea 3**
Person 1	Person 1 puts down 1st idea	...2nd idea	... and 3rd idea
Person 2	Person 2 can come up with their own idea	....or snowball a previous idea	Or combine two previous ideas to create a new idea
Person 3	Person 3...		
Person 4	...and person 4 follow suit	.... Creating new ideas, snowballing or combining	...until the whole table is full of ideas to filter



Criteria	Less desirable descriptor	More desirable descriptor
How much will it cost to make?	Expensive	Cheap
Is it feasible to do?	Feasible	Impossible
Will it be difficult to do?	Difficult	Simple
Is it novel?	Exists	Innovative
Is it important to those that need it?	Negligible impact	Valuable/ beneficial/ important
Does it have room to evolve?	Specific	Broader impact

Fig. 4.7 The 2 × 2 Matrix activity is a fantastic way to filter ideas early and effectively based on their merit. Create a 2 × 2 grid with an X and Y axis. On each axis, put forward a less and more desirable descriptor of a criteria to evaluate the idea, for example, "How much would it be to make the idea?": expensive (less desirable) and cheap (more desirable). Categorize each idea based on the criteria to narrow down the ideas to pursue. If you have several ideas in the "pursue category", you can run another round of the matrix with different criteria on the axes. Some examples of criteria have been included

Once a pool of ideas has been generated, a fantastic exercise we have implemented is the "2 × 2 Matrix" as a means of filtering ideas on their potential based on established feasibility criteria such as cost, difficulty, innovation, novelty, and so on (Fig. 4.7). This activity is an effective way to filter ideas in a diplomatic manner, so as to not have the rejection of ideas be misconstrued as a reflection of the individual that put forward the idea.

Although the Design Thinking process puts forward individual stages, the actuality is that each stage bleeds into each other. That is, for example, there will always be elements of defining, empathizing, and testing during the ideation phase. This is how the best ideas are developed. It is therefore essential to encourage students to continually undergo this iterative process within the groups, but to also have formative feedback throughout the Design Thinking process, whether it is from the teachers, peers, or external mentors. As mentioned previously, our initial problems are put forward by leading academics in the respective field. We invite the mentors to attend class periodically throughout the course to provide feedback to the students, answer their questions, and validate their ideas regarding feasibility and novelty. This is especially important in science and healthcare given the complexity of the problems posed.

4.4.3 Completion

The ultimate culmination to all their hard work of the course is the showcase of their pitch. This is a very daunting task for many, and so it is our responsibility as the teacher to make this occasion as special as we can. Do not just treat it as another

assessment—celebrate them. Invite the mentors and anyone else that has helped the students along the way. Wherever we could, we would bring some snacks to celebrate their hard work at the end of the pitch, where they can unwind and interact with the class and invited audience members. This small celebration from you as the teacher speaks volumes to the students, as it is a means of validation and acknowledgement of their achievements.

The pitch content will vary between courses depending on the focus and intentions of the course. We have included an example of pitch points in Table 4.6 that we use in our courses for 15–20-min pitch. However, what we would stress is that each student speaks and answers questions. This is one of the most valuable exercises the students will complete in the course, to show their understanding and contribution. Further, the structure of the pitch will vary from project to project. The layout presented below is simple one example of a pitch (Table 4.6); however, it may not be the more effective way for a group to pitch their specific idea.

An interesting question to arise while writing this chapter is whether, outside of the overall celebrations, should there be prizes for the best pitch presentations? And if so, what kind of prizes? We have debated both sides, and instead of having a clear-cut decision, we feel it comes down to the size of the prize. When BIE first began, there was a significant monetary prize for the best project, with the intention of using the funding to kickstart the scientific investigation into the hypothetical idea. Although the intent was genuine and significantly ignited the students to perform exceptionally, it resulted in significant internal fighting within the winning groups, whereby some group members attempted to bully the others out of the project and to sign over their IP rights. Ever since, prizes have been only symbolic in nature,

Table 4.6 Questions to consider when composing a pitch

Content to cover
The open
How can we hook the audience in?
The what
What is the problem?
Why is it a problem? Why should we care?
The who
Who is affected by the problem?
What is the extent of the problem? (Market analysis)
The how
How are you solving the problem—what is your solution?
How does it work? (Scientific and/or technical explanation)
How does it compare to existing alternatives and why/how is your idea better or novel? (Intellectual property)
How will it be made, for how much (cost), and how much can you make (profit)? (Production and manufacturing, financial analysis, competitor analysis)
How does it solve the problem you described?
The close
Who are you (the team)?
Why should we (the audience) join you to solve this problem with your idea?

such as certificates for all participants, with an added note of “best pitch” or “people’s choice”, plus a small token. This is a significantly fairer approach without burdening the students with added pressure.

4.5 Conclusion

Design Thinking is becoming an increasingly valuable tool, not just in business and IT where it has been readily implemented, but in all areas that it expands into, such as science and healthcare. Incorporation of Design Thinking into healthcare education is of significant value as it creates a heightened desire and responsibility of training healthcare workers to create healthcare experiences in which the patient and their wants and needs are the center of attention.

Implementing Design Thinking into healthcare course work is a challenging task but is ultimately rewarding both for the students and for the teachers. It allows a different sense of accomplishment, in which the students are empowered in their ability to tackle a difficult problem and bring a valuable and needed solution to the table. We have outlined in this chapter different perspectives and exercises that we have implemented in our own Design Thinking courses that we feel are of most value. But these tasks are nothing without creating the right environment for Design Thinking. So, we would like to leave you with a few final thoughts about how to create an environment that invokes thoughtfulness and creativity in our students:

- Encourage the students to fail (in their ideas), and often. And we use the word “fail” loosely, because their ideas are not failures, but opportunities for later time, or opportunities to build upon or pivot.
- Show them that it’s ok to not have all the answers all the time, including the teacher. Your students will be working on a variety of complex problems, and it is not expected for you to be an expert in it all. I tell my students truthfully if I do not know something, and instead I use it as a learning opportunity for both me and the students as it opens the door for questions and ideas from everyone.
- Ensure that all ideas are heard and noted. Often quiet students may feel embarrassed or fearful to contribute, so be sure to ask them questions and have all voices heard. This will also encourage the other team members to do the same.
- Bring in external opinions, whether it be mentors, scientists, patients, and so on. Students going through this process may go down a rabbit hole of focus and may make the tasks at hand daunting and unachievable. Having the same people and same voices around them further spurs this on. Instead, inviting sporadic external influence will bring about fresh and new ideas and perspectives and will re-energize the students for the tasks.
- And finally, create a relaxed atmosphere. Remove the teacher-student barrier and instead allow for casual conversation between you and the students. By breaking down this wall, students are much more comfortable and willing to contribute to class discussions. Just have fun with it all!

References

1. Wrigley C, Straker K (2017) Design thinking pedagogy: the educational design ladder. Innov Educ Teach Int 54(4):374–385
2. Panke S (2019) Design thinking in education: perspectives, opportunities and challenges. Open Educ Stud 1(1):281–306
3. Wolcott MD, McLaughlin JE, Hubbard DK, Rider TR, Umstead K (2021) Twelve tips to stimulate creative problem-solving with design thinking. Med Teach 43(5):501–508
4. Sandars J, Goh P-S (2020) Design thinking in medical education: the key features and practical application. J Med Educ Curric Dev 7:2382120520926518
5. Madson MJ (2021) Making sense of design thinking: a primer for medical teachers. Med Teach 43(10):1115–1121
6. Beaird G, Geist M, Lewis EJ (2018) Design thinking: opportunities for application in nursing education. Nurse Educ Today 64:115–118
7. Padagas RC (2021) Design thinking in a professional nursing course – its effectiveness and unearthed lessons. Revista Romaneasca pentru Educatie Multidimensionala 13(2):132–146
8. Park M, Giap TT, Jang I, Jeong M, Kim J (2022) Listening to patients' voices: applying the design-thinking method for teaching person-centered care to nursing students. Nurs Forum 57(1):9–17
9. Ryan RM, Deci EL (2000) Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. Am Psychol 55(1):68–78
10. Baer J (2013) Teaching for creativity: domains and divergent thinking, intrinsic motivation, and evaluation. In: Gregerson MB, Kaufman JC, Snyder HT (eds) Teaching creatively and teaching creativity. New York, Springer, pp 175–181
11. Miller JE, Trimbur J, Wilkes JM (1994) Group dynamics: understanding group success and failure in collaborative learning. New Dir Teach Learn 1994(59):33–44
12. Johnson D, Johnson R (2018) Cooperative learning: the foundation for active learning. In: Active learning - beyond the future. IntechOpen, London
13. Johnson DW, Johnson RT (2009) An educational psychology success story: social interdependence theory and cooperative learning. Educ Res 38(5):365–379
14. Johnson DW, Johnson RT, Smith KA (2014) Cooperative learning: improving university instruction by basing practice on validated theory. J Excell Univ Teach 25(4):1–26
15. Felder RM, Brent R (2007) Cooperative learning. Active learning, ACS symposium series, vol 970. American Chemical Society, Washington, pp 34–53
16. Owen CL (2007) Design thinking: notes on its nature and use. Design research quarterly 2(1):16–27
17. Improving self- and peer assessment processes with technology Campus-Wide Information Systems (2009) 26(5):379–399. https://doi.org/10.1108/10650740911004804