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Reimagining premedical foundation blended curriculum through design thinking: A qualitative study

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Abstract

The shift in teaching and learning following the pandemic encouraged faculty and teaching staff to seek creative teaching methods, find different means to engage students online, and provide students with the opportunity to be creative themselves and enjoy their learning journey. In the Spring of 2021, a design thinking (DT) unit was designed and integrated into the English for Academic Purposes (EAP) course for foundation students enrolled in a premedical programme at Weill Cornell Medicine-Qatar. The teaching team consisting of the course director, a teaching specialist, and a librarian curated a series of reading materials to introduce students to DT and its applications in different interdisciplinary areas including healthcare and medicine. As students were getting acquainted with the literature, they were also working in groups of three to identify a problem in their everyday lives, investigate the problem, and brainstorm a human-centred solution. The teaching team provided the students with guiding instructions throughout the DT project by delivering mini presentations for each of the four phases. The college's learning management system Canvas was used to facilitate online group work and create a series of mini assignments to assess students' deliverables. The problems tackled by the students and the range of solutions they presented show the highly creative potential of first-year college students, their awareness of current issues in various organisations, particularly in healthcare, and their ability to leverage technology to design solutions for everyday

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problems. This paper presents the findings of a programme improvement project that investigates two questions in relation to the effectiveness of technology-enabled DT for foundation students' learning and their perceptions of their learning through exposure to DT. The paper analyses the findings from students' reflections on the DT project and provides a clear description of the developed DT unit and its integration in an undergraduate curriculum to promote students' creativity, problem-solving, and teamwork.

1. Introduction

The sudden shift to online teaching that higher education institutions experienced during the pandemic prompted faculty and teaching staff to revisit their curriculum, evaluate their deliverables, and consequently revamp their courses in favour of a more engaging and creative student experience.

The current study takes place in a foundation year of a premedical curriculum in a medical college in Qatar and aims at improving the programme curriculum through the introduction of a DT project mediated by technology. Prior to the pandemic, every spring semester students would enrol in an experiential learning project where they shadow healthcare practitioners in a hospital setting and gain hands-on knowledge and understanding of what it takes to be future doctors. However, due to the pandemic, in the spring of 2021, students embarked on a new project. Twenty-two students who were enrolled in the English for Academic Purposes (EAP) course participated in a three-week Design Thinking (DT) project. The course director, a teaching specialist, and a librarian collaborated to brainstorm and implement this project as a new teaching method that encourages students' engagement, fosters their creative skills, and most of all, establishes a sense of community through teamwork. This study aimed to investigate two research questions: 1. What are students' perceptions on what they learned from completing a DT project? 2. To what extent is technology-enabled DT effective as a substitute for the earlier shadowing of medical professionals by premedical students?

2. Literature review

One of the world's earlier nationwide governmental initiatives is *The Design Council* which was established by Winston Churchill following World-War II to "support Britain's economic recovery" (Design Council, n.d.). The *Design Council* developed the *Double Diamond* method that consists of four phases (Ball, n. d.). The first phase, known as *Discover*, encourages individuals working towards solving community problems to understand the problem from a human-centred perspective by talking to people affected by the issue. The second phase is to *Define* the problem, or the challenge, based on the information collected in phase one. The third phase, *Develop*, encourages individuals to brainstorm individually and collectively to find solutions to the problem or challenge taking the people affected by this problem into consideration. The last phase is to *Deliver* a solution by testing out different scenarios, eliminating the ones that do not work and improving upon the ones that look promising.

In higher education, John E. Arnold launched a series of Creative Engineering seminars at Stanford University in the 1950s which were the basis of the 2005 establishment of the current Stanford d.school (von Thienen et al., 2017). The founder of *Stanford d.school*, David Kelley, is also the owner of IDEO, a leading company in DT established in 1991, which was behind the design of the first computer mouse for Apple (Ideo, n.d.). In their DT approach, the d.school uses a five-step process that starts with *Empathize*, continues with *Define*, *Ideate*, *Prototype* and finishes with *Test* (Institute of Design at Stanford, n.d.). As James (2017) describes it, "designers must listen and absorb before generating ideas and then implementing them" (p. 1). Meanwhile, a similar movement was taking place in Europe when the Hasso Plattner Institute established the *D-School* in 2007 that also adopts a human-centred approach to find inspiration "through careful observation and qualitative research," creating solutions, and validating these solutions with the people they are designed for in order to refine the solutions. This approach emphasises solutions based on people's desires (openHPI, 2018).

However, some studies have considered DT to increase unfounded confidence and creativity. Jen (2017) considers that criticism, which is the foundation of good design, is omitted from the linear process that the current DT schools are adopting. In her presentation entitled "Design thinking is business bullsh*t," Jen (2017) considers that the process of DT turns the design process into a simplistic one that lacks 'messy' evidence that every designer needs. Vinsel (2018) goes further by considering the DT process a reiteration of old writing techniques "taught in a freshman writing class" (n. p.), where you consider your audience (empathize), define your topic (define), think (ideate), write down your thoughts (prototype), and get feedback (test). Furthermore, Vinsel (2018) warns higher education against adopting DT stating that he considers it a commercialization process, "making education a superficial form of business training" (n. p.). Nevertheless, this seemingly simplistic approach to DT targets basic skills that first-year premedical students do

need in order to prepare them to move to more complex and advanced skills that involve evidence-based problem solving.

"Design Thinking combines inspired and organized creativity approaches systematically and comprehensively" (von Thienen et al., 2017, p. 31). By using the word *inspired*, von Thiene et al. (2017) denote the human-centred approach while using the word *organized* to refer to a process that helps in creating, prototyping, and implementing the solution. Efeoglu et al. (2013), Brown (2008), and Oster (2008) have highlighted the important role of the 'problem' in initiating and streamlining the DT process, while Schön (1983) and Luka (2014) considered the reflection process in DT as the basis of any solution. Another important aspect of DT is teamwork as it is comprised of the independent component - which "offer[s] the expertise of many individuals" - and the collaborative one - which "provide[s] shared responsibility for decision-making" - complementing each other (Salas et al., 2000, p. 340). The value of DT lies in teamwork, leadership, and innovation (Brown, 2009). However, teamwork also presents some challenges in the team dynamics, where "misunderstandings and conflicts, bad preparation, or group decision biases" might also arise (Eppler & Kernbach, 2016, p. 86). Another important transformation in DT is the move to a virtual work environment. While in the past, the DT process would rely on face-to-face collaboration and a hands-on approach to creativity (Brenner et al., 2016; Meinel & Leifer, 2012) necessitating a physical presence, today's technology allows more flexibility and supports virtual work among team members (Maynard & Gilson, 2014).

2.1 DT in healthcare

DT emerged from architecture, design, and art (Johansson-Sköldberg & Woodilla, 2009) and was later adopted in business (Kelley & Littman, 2001), engineering (Dym et al., 2005), management (Johansson-Sköldberg et al., 2013), education (Rauth et al., 2010), healthcare (Kim et al., 2017), and recently in Big Data innovations (Pham et al., 2021).

In healthcare, Nusem et al. (2020) studied 30 cases to understand how DT, and therefore innovation, is used and applied. The authors observed two dimensions to design. The first dimension is concerned with whether design is "driven by a challenge" which they called a reactive approach, or whether design is "driven by an opportunity," considered to be a more proactive approach (p. 17). The second dimension is concerned with whether the design is intended for internal users such as healthcare practitioners or external users such as patients (p. 18).

The current developments in healthcare - such as the increased use of artificial intelligence to care for remote patients - as well as the continuous challenges - such as social inequity and access to healthcare - require that future healthcare providers acquire "the knowledge, skills and attributes that future patients, health systems and populations need" (Davis, 2018, p. 1005). Although DT is already in use to improve healthcare through space design and new tools and products, it needs to be used to tackle more important issues such as patient transportation, miscommunication between healthcare providers and patients, and implicit bias in patient treatment (Kim et al. 2017). It is therefore important to embed DT in healthcare systems and encourage future doctors to think about patients' experiences and values as an important part of their future role. Furthermore, in response to Covid-19 challenges, Bassin et al. (2020) go beyond embedding DT into healthcare systems by suggesting appointing healthcare architects with healthcare experience and "knowledge of evidence-based design" to "support a paradigm change [...and] help solve health care's greatest challenges" (p. 326).

2.2 DT in medical education

Wolcott et al. (2020) provided a 12-tip strategy to help healthcare educators adapt and implement DT in their curriculum. These 12 tips can be divided into three phases:

a. *Prepare for DT* by gathering resources and examples to develop students' knowledge about DT and prepare them to "commit to design thinking mindsets" (Wolcott et al., 2020, p. 3);

b. *Engage in DT* through ice-breaker activities. Build students' empathy through observation and engagement in communication with the users to instil a human-centred approach. Have students create a problem statement to identify the challenge and the desired outcome using the format "How might we…?" Seek inspiration and use analogies from other disciplines. Encourage prototyping and collect feedback to improve the solution;

c. *Support DT* by encouraging quantity of ideas over quality. Help students express their ideas using data visualization techniques such as storyboards, role plays, and videos. Promote a teamwork environment free from judgement, where team members build trust and accept failure. Ensure the DT process is enjoyable by integrating "play and rest into the process" (Wolcott et al., 2020, p. 6), and finally seek opportunities to help peers and administration understand the benefits of DT and adopt it.

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Furthermore, Wolcott et al. (2020) consider that using DT in medical education can address many problems such as improving students' study habits, designing and implementing online teaching, creating innovative assessments, and supporting students' wellbeing. Thakur et al. (2020) agree that the use of DT provides solutions to complex problems that emerged during the pandemic in the area of patient care, especially the "rapid implementation of virtual care" that allows medical students to train in telemedicine.

2.3 The local context: Medical education in Qatar and DT

Since the 1960s, Arab Gulf countries have witnessed an exponential growth in the establishment of higher education institutions offering a medical degree (Hamdy et al., 2010). Many local and transnational higher education institutions have established medical colleges to cater to the local needs of doctors and healthcare providers. According to the World Directory of Medical Schools (2016), Saudi Arabia ranks first with 35 institutions, followed by the United Arab Emirates with eight institutions, Bahrain with three institutions, Qatar and Oman with two institutions each, and Kuwait with one institution.

In Qatar, Weill Cornell Medicine-Qatar (WCM-Q) was the first institution to offer a medical degree. It is a branch campus of Cornell University that was established in 2001 (Weill Cornell Medicine-Qatar, n.d.). The second institution is a home-grown college of medicine established at Qatar University (QU) in 2014 (College of Medicine, n.d.). While WCM-Q offers a premedical curriculum that can vary between two and three years (including the foundation year), both colleges offer a six-year medical degree. Even though DT is absent from the formal curricula of both institutions, a promising step was undertaken by QU announcing the launch of eight new modules taught in Arabic and English that include DT, entrepreneurship, and leadership "in response to global challenges" (Qatar University, 2021).

As there is growing interest in utilizing DT as a problem-solving methodology in both the global and local context of Qatar, this paper contributes to the current scholarship on the importance of DT in medical education through the implementation of a pilot DT unit in the Spring semester of 2021 for foundation students enrolled at WCM-Q. The DT unit introduced students to the importance of adopting a human-centred approach to healthcare and putting their creativity and innovation into practice while replacing a previous hospital shadowing experience in the premedical curriculum that was no longer possible following the Covid-19 pandemic.

3. Theoretical Framework

The DT unit implemented in the spring 2021 semester emerged from the social constructivism theory, described by Shulman and Carey (1984) as a way to construct meaning through interactions between an individual and a context. It is a process in which an individual builds knowledge, skills, and dispositions, through socializing (Carroll, 2014), which DT facilitates since it is team-based and takes into consideration the social context for which the innovative solution is created and in which it would be implemented.

In addition to approaching a problem rooted within a greater social context, the team-based approach to DT also allows for each student to work within the individual student's zone of proximal development (ZPD) to develop and enhance his or her own learning and understanding of new concepts. Following Vygotskian approaches to social constructivism, ZPD can be defined as the zone between tasks that the student cannot yet do on his or her own but would be able to accomplish with social support from teachers or peers that are more competent within the relevant academic context (Slavin, 2003; Karpov & Haywood, 1998). Applications of social constructivism and Vygotsky's ZPD concept have frequently been utilized within the second language learning context (Lantolf, 2000; Nassaji & Cumming, 2000; Marchenkova, 2005). Furthermore, social constructivism is found to create a holistic learning experience for students relative to the social and cultural environments around them (Efland et al., 1996; Greene, 2005; Trent et al., 1998; Gross & Gross, 2016). As designers of learning experiences, teachers, according to Cochrane and Munn (2016), are designers "of an ecology of resources … that stimulate student discussion and creativity" (p. 310).

4. Research design

4.1 Research methodology

A qualitative case study was used to collect and analyse students' perceptions of the DT experience. Case studies are usually used to analyse and evaluate a specific programme or event, "are bounded by time and activity" (Creswell, 2014), and tend to investigate a phenomenon "within its real-world content" (Yin, 2009, p. 15). Cassell and Symon (1994) consider that a case study allows for a qualitative research approach (Creswell, 2014). They are used in education (Gulsecen & Kubat, 2006) as they allow the researcher to understand the user perspective that cannot be represented through quantitative data (Zainal, 2007).

Rather than looking for generalization, a case study allows us "to appreciate the uniqueness and complexity" of an issue by observing and understanding (Sake, 1995, p. 16).

Twenty-two students enrolled in the EAP course participated in a three-week DT project. This study aimed to investigate two research questions:

1. What are students' perceptions on what they learned from completing a design thinking project?
2. To what extent is technology-enabled design thinking effective as a substitute for the earlier shadowing of medical professionals by premedical students?

Students' deliverables consisted of a 10-minute live presentation for each group summarizing the four stages of their DT project and an individual 300-word reflection piece that gathered students' perceptions of the utility or applicability of DT in their future career as healthcare professionals. These reflections were used as the primary qualitative data to inform this study. The reflection prompt asked students to reflect on the DT project activities, the process, the teamwork, the learning, and the solution students were able to identify. The reflection prompt also asked how students perceived the utility or applicability of DT in their future career as healthcare professionals. After the reflections were collected, they were uploaded to the qualitative data analysis software Atlas.ti (atlasti.com) and analysed in light of the research questions. The first round of analysis consisted of creating open codes that were divided into categories and grouped into themes.

Online communication technologies arose as natural tools for delivering online learning, especially amidst the pandemic, using the learning management system Canvas. Students also used Canvas when they met in groups to work through their projects and develop their project ideas, to communicate with their instructors, and to post their reflections. Student-student communication and collaboration took place using informal social media platforms such as WhatsApp and Google docs to complete the project.

4.2 Overview of DT unit as a teaching method

In previous years, the spring semester syllabus included an experiential learning component where foundation students enrolled in a shadowing experience in one of the healthcare institutions in Qatar or participated in a patient simulation project in the college simulation lab. However, following the Covid-19 restrictions and the limited access to healthcare facilities and training labs, we needed to rethink our pedagogical practice and ensure we incorporated the teamwork element that is essential in future doctors' careers. DT was one of the options that would meet the needs and desires of students while also creating a community of learners that would help students overcome online isolation and encourage them to engage in and benefit from teamwork.

The DT approach was used as the teaching method, and a DT unit was designed and implemented over the course of three weeks. In the first week, two live sessions were held on the video conferencing platform Zoom. The first session introduced students to the project, its learning outcomes, and the timeline. Phase I - *Discover* - was covered in the first session where students learned about the importance of spending time understanding a problem from a human-centred perspective by talking to people affected by the issue. The next step during this first session was to form teams and agree on a problem that students would investigate over the next two days. The next session took place at the end of the week. In this second session, students learned how to *Define* the problem, or the challenge, based on the information collected in phase one. Students were then given two days to work in teams to propose a definition of their problem.

The second week was dedicated to the third and fourth stages: *Develop* and *Deliver*. The first session introduced students to the power of brainstorming individually and collectively to *Develop* solutions while taking into consideration the data collected in the first week and the people affected by each team's chosen problem. Padlet (https://padlet.com) was used for individual brainstorming and as a convenient way to disseminate ideas among group members online. The second session of week two presented students with ways of *Deliver*ing a solution by testing out different solutions, eliminating the ones that did not work, and improving upon the ones that looked promising.

The following table (Table 1) presents the different phases that took place in each session. It includes the learning outcomes of each session and online materials made available to students in Canvas, including class presentations, additional readings, and YouTube videos. The table also provides a description of the expected deliverables and due dates.

Week three was dedicated to students' live group presentations and individual reflections on their DT projects. Each team was allocated 10 minutes to present their chosen problem and the solution, while also briefly summarizing the different DT stages they went through. Individually, students wrote a 300-word reflection paper to answer the following question "How do you see the utility or applicability of design thinking in your future career as a healthcare profes-

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sional?" while also reflecting on the DT project activities, the process, the teamwork, the learning, and the student-created solution to the identified problem.

Throughout these three weeks, in addition to online resources, a list of essential and optional readings was made available to students in Canvas. The complete list is available in Appendix A.

Students were divided into seven groups and worked as a team throughout the entire DT process submitting small assignments to monitor their progress. Students identified the following DT idea projects:

- *Group 1*: An electronic centralized portal for sharing patient information across all national healthcare centres.

4.3 Students' DT projects

Table 1. DT Unit Timeline, Online and Class Materials, Learning Outcomes, and Deliverables

Timeline	**Week 1 Session 1**	**Week 1 Session 2**	**Week 2 Session 1**	**Week 2 Session 2**	**Week 3**
DT Phases	Discover	Define	Develop	Deliver	Group Presentations
Online Materials in Canvas	What is design thinking? (YouTube video) The importance of Design Thinking in Medical Education (Badwan et al., 2017)	Medical Design (Nusem et al., 2020) How to Respond to the Covid-19 Pandemic with more Creativity (Cohen & Cromwell, 2020)	Using Rapid Design Thinking (Thakur et al., 2020) Design-Driven Leadership (Koomans & Hilders, 2017)		
Live Class Materials	Introduction to the DT unit: purpose, learning objectives and outcomes, deliverables timeline. Presenting on research methods to understand the problem: interviews, observations, and experience	Presenting on synthesizing the gathered information, and establishing connections between the different stories collected in Phase I. Providing an example of a Brief, the 5 Questions, and the *How might we…?* Question	Presenting on the power of individual and collective brainstorming (using IDEO rules of Brainstorming)	Presenting on and developing possible solutions and prototypes through different methods: sketching, role-playing, digital materials, playdough, Lego…	
Learning Outcomes	Identify the Problem	Synthesize the information you collected and prepare a Brief. Answer the 5 Qs and Develop the *How might we…?* question	Brainstorm solutions	Decide on a solution and develop it	

Table 1. (cont.) DT Unit Timeline, Online and Class Materials, Learning Outcomes, and Deliverables

Timeline	Week 1 Session 1	Week 1 Session 2	Week 2 Session 1	Week 2 Session 2	Week 3
Deliverables	Go to Canvas and enter the Problem or Challenge that your team is going to explor Start your research by interviewing people around you, observing, or even experiencing the product or service under investigation. Remember to take notes as you will be writing a Brief or summary	Go to Canvas and enter your Brief (150-200 words) Provide detailed answers to the following 5 questions: *Who, What, When, Where, and How* Develop the *How might we...?* question using the examples shared with you	Brainstorm individually for possible solutions As a team, get together online, share your individual brainstorming, and come up with a common brainstorming map Go to Canvas and share your team brainstorming Map	Go to Canvas and upload a video in which you share one of the solutions you developed Prepare for your live 10-min group presentation	**Final Assignment:** Write an individual reflection piece (250-300 words) in which you reflect back on this activity, the design thinking process, teamwork, your learning, and the solution you were able to identify. How do you see the utility or applicability of design thinking in your future career as a healthcare professional?

- *Groups 2 and 4*: An online app providing guidance for local high school students transitioning to university.
- *Group 3*: Training for emergency operators in English language skills.
- *Group 5*: An online app for providing support for physiotherapy patients through an online appointment service, customized exercise videos, and the use of a drone to deliver medicine and equipment.
- *Group 6*: A home medicine dispenser with a wrist band and an app.
- *Group 7*: Improving an already existing app for booking hospital appointments by making all local health centres accessible through the app and including more interface languages.

5. Findings

Students' reflections were exported into Atlas.ti where 150 open codes were extracted. These codes were revised and grouped together resulting in eight categories that the authors agreed upon and were grouped into three main themes. Table 2 summarizes the themes and categories that emerged from the open codes and their recurrence in students' reflections.

5.1 Theme 1: DT challenges

The first theme *DT Challenges* can be divided into two categories: *Challenges of Engaging with DT* and *Challenges of Engaging in Teamwork*. While these two categories have the lowest instances of recurrence, they still represent the challenges that students faced throughout this project.

The *Challenge of Engaging with DT* is expressed by eight students. The first student stated that "it was difficult to identify a well-defined problem as the group mainly focused on developing solutions" (student 6). Students 4 and 22 acknowledged that there were disagreements within their groups about identifying a problem, while student 8 admitted questioning the purpose of DT - "Why are we doing this?" - especially in the first phase of the project. Another student was concerned with defining the problem, as described in their reflection "our discovery phase was too short, and we would need to conduct a far more in-depth investigation … in order to understand the issue more clearly" (student 7). One student expressed scepticism at the beginning of the DT project by questioning its "effectiveness … in solving human-centred problems" (student 9), while another student was concerned as to whether DT would be useful for their future career (student 21).

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Table 2. Themes and their Respective Categories that Emerged from Open Coding

Themes	Categories	Recurrence
DT Challenges	Challenges of Engaging with DT	8
	Challenges of Engaging in Teamwork	5
DT Experience	DT as a Learning Experience	16
	Importance of Teamwork and Collaboration in DT	16
	DT as an Opportunity for Creativity	19
DT Application	DT as a Human-Centred Approach	15
	Importance and Application of DT in the Real World	19
	Value of DT	21

One student admitted that "there is already an app similar to our solution" (student 7). However, instead of students giving up on the app, they were able to evaluate the app already in use in an attempt to improve it and add to its functionality and utility. Although this improvement was not mentioned in students' reflections, it was shared as part of their solution during the group's presentation in week three.

The *Challenges of Engaging in Teamwork* were expressed by five students who found teamwork and communication difficult during the DT project. One student felt "left out" of the group conversation (student 5), while another student suggested that "each person had a different point of view" (student 6), which made the communication process a little tense. Difficulties in communicating as a team over social media were also cited by students as one student suggested that it was "difficult to reach other members" of the team via the team's chosen social media app (student 19). Student 15 considered that their team faced "time management" issues, while student 21 mentioned that the Covid-19 lockdown situation made group activities difficult to undertake.

5.2 Theme 2: DT experience

The *DT Learning Experience* includes three categories. The first category is *DT as a Learning Experience*, and 16 students seemed to appreciate the opportunity to be introduced to and to apply DT. Students used words such as wonderful (students 2 and 6), successful (student 3), enjoyable (students 5, 13, and 19), interesting (student 5), helpful (student 10), fun (student 20), delightful (student 11), insightful (student 13), and phenomenal (student 17) to describe their experiences engaging with DT. Other students mentioned that the teaching pedagogy used to introduce them and guide them through the DT process made their learning experience less overwhelming, simple, and smooth (students 3, 6, 10, 13, 15, 21, and 22). Students also acknowledged the role the DT project played in putting into practice important skills such as critical thinking, communication, and listening (students 9, 12, 17).

The second category under this theme is *Importance of Teamwork and Collaboration in DT*. Under this category, 16 students commented on their appreciation for the collaborative nature of problem-solving (students 9, 10, and 12), the importance of different perspectives (students 6, 10, 16, and 22), the usefulness of individual skills when working as a team (students 11, 15), and the chance to work with other students (students 3, 4, 8, 11, 13, 19, and 21).

Among the aforementioned comments, the importance of different perspectives proved invaluable for one group of students as personal experiences of one of their team members (cited in student 15's reflection) led to their selected problem for the DT project. In addition, students mentioning the value of individual skills could be attributed to relying on group members with technical expertise in survey and data collecting software, which was necessary for many of the groups' projects when defining their chosen problems.

The last equally important category under this theme is *DT as an Opportunity for Creativity*, and 19 students confirmed that the DT experience presented them with an opportunity to be creative and innovative. Some students commented on how DT opened their eyes to "different perspectives and approaches [to] problem-solving" (student 9) and promoted "innovation and ingenuity" (student 6). Additionally, two students also noticed how DT helped them

"combine multiple solutions to maximize" efficiency in problem solving (students 20 and 22).

5.3 Theme 3: DT application

The final theme, *DT Application*, consists of three categories - the first one being *DT as a Human-Centred Approach*. Fifteen students commented on the human-centred aspect of DT, how they learned about real-world problems (students 1, 6, 13, 17, and 19), and how they reached out to people to collect field data to help them understand the problem and better address it (students 2, 7, 9, 10, 11, 12, 14, 16, 18, and 20).

The second category under this theme is *Importance and Application of DT in the Real World* which yielded 19 codes collected from 19 students' reflections. These 19 students suggested that DT can be applied in their future careers as healthcare professionals. As one student eloquently put it:

> I expect to find multiple cases where design thinking needs to be applied in medicine as it is a field of infinite new challenges. This experience provided me with an effective approach to facing obstacles and solving issues. In the future, I expect to use this process to analyze a problem, determine its causes, and quickly come up with a solution. (student 22)

The last category under *DT Application* is *Value of DT*. It scored the highest number of codes generated through students' reflections. Out of 22 students, 21 commented on the value of DT in their everyday lives and their future careers as medical professionals. One student's comment summarizes this category:

> As a future doctor, design thinking allows us to critically think about complex problems we might encounter and improve the overall quality of health care provided to the patients. In conclusion, design thinking allows a great timely opportunity to evaluate users' needs and requirements and distinguish promising opportunities and get to the root of the issue. (student 19)

6. Discussion

This section provides a discussion based on the original research questions and the data generated by the themes that emerged from the students' reflections.

6.1 Research Question 1: What are students' perceptions on what they learned from completing a design thinking project?

Many of the student reflections pointed to difficulties in defining the problem, which is considered the most important step towards an innovative solution-oriented process in DT (Efeoglu et al., 2013; Brown, 2008; Oster, 2008). Student 6 commented that it was difficult to identify a problem as the student's group was overly focussed on developing solutions in the beginning. In addition, student 7 reported a desire for more time in the discovery phase and suggested that a more in-depth investigation would have helped the student's group better understand the problem. It would seem the challenge of defining a problem in DT represents an opportunity for students participating in the project. Often the creative process is short-circuited by design teams that rush to find a solution without fully investigating the problem. Perhaps this is one of the greater strengths of using DT in the classroom. Due to the structured approach to problem solving, DT teaches students the importance of focussing on defining a problem before seeking a solution. Furthemore, the focus on the problem and the users who are affected by the problem was described by Nusem et al. (2020) as the reactive approach to DT and helps students to learn the importance of defining a problem and how it relates to its audience before engaging in designing a human-centred, user focused solution.

Teamwork emerged as an important element of students' DT experience and was somewhat amplified by the Covid-19 situation. As classes were held in a hybrid format and students were not on campus as often throughout the semester, students had to learn to utilize digital tools to support their team's efforts. Communicating among group members through digital means proved challenging for some students. While student 19 cited that "the experience could have been more pleasurable if the project was completed on site as occasionally it would be difficult to reach other members" via social media and messenger applications, this student also acknowledged that despite these challenges, "the group was very collaborative and the work was distributed equitably between the four members." Technological developments in the area of social media and the availability of a variety of formal and informal communication channels have improved virtual teamwork and created more opportunities for members of the same team to collaborate on projects while in different geographical spaces (Maynard & Gilson, 2014). However, the challenges described by some students here can be traced back to the task itself and the set time frame that require team members to "re-evaluate and adjust tasks and processes, which, in turn, relies on effective

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communication… [and] requires a commonly shared vision" (Redlich, 2019, p. 10).

Furthermore, DT "is inherently based on teamwork and comprises creativity, multidisciplinarity, collaboration, co-creation and iteration" (Redlich, 2019, p. 56). The majority of the students quickly adapted to using social media and messenger applications as a way to communicate. Student 2 stated that due to her excitement she and her group were "talking nonstop on a WhatsApp group discussing the topic of the project." This group also utilized Zoom as a way to interview members of the community to gain a deeper understanding of their chosen problem.

Overall, students' perception of *DT as a Learning Experience* was positive. Similar to what Wolcott et al. (2020) have found when using DT in medical education, we can confirm from students' reflections that implementing a DT unit in premedical education can improve students' study habits by "enhanc[ing] their communication skills" (student 12) and putting into practice "complex critical thinking" (student 9) while supporting students' wellbeing by introducing an "enjoyable" (students 5, 13, 19 and 21) and fun (student 20) activity and allowing them to choose a topic they "are passionate about" (student 8).

Finally, students appreciated the whole experience by acknowledging the value of the DT experience on different levels, be it personal, educational, or how it relates to their future career. Having 21 out of 22 students reflect and share their thoughts on its value proves that, as a pilot project, the DT unit was a successful endeavour that allowed us to create a sense of community within a blended classroom. Students were able to collaborate, exchange ideas, learn from each other, and contribute to creating human-centred solutions.

6.2 Research Question 2: To what extent is technology-enabled design thinking effective as a substitute for the earlier shadowing of medical professionals by premedical students?

The value of teamwork and diverse viewpoints is critical in medical practice and healthcare delivery, which reinforces the pivotal role of DT in medical education and the need for curriculum developers and instructional specialists to incorporate DT in the curriculum. Therefore, many students directed their attention to the value of teamwork, which was one of the core learning outcomes of the earlier shadowing experiences that premedical students were required to attend prior to the pandemic. The DT unit fulfilled this curricular objective by highlighting the various skills that team members needed to share within their groups.

During the delivery phase of the DT project, students were introduced to online mind mapping tools during class, which they used to brainstorm and share ideas within their group. Padlet, which is often used as a tool for brainstorming in many classrooms, was used as a way for students to share ideas with their groups outside of the classroom. These online adaptations and improvisations served as an improvement to the conventional approach that is taken during in-person DT *Delivery* phase sessions using post-it notes. Indeed, the challenges of communication among groups provided an opportunity for groups to engage with various 21st century technologies that support group communication and enable connections with the external community.

Specifically, students commented on their appreciation for the collaborative nature of problem-solving (students 9, 10, and 12), the importance of different perspectives (students 6, 10, 16, and 22), and the usefulness of individual skills when working as a team (students 11, 15). The problem-solving nature of DT creates an opportunity for students to construct meaning from the context of the situation. Furthermore, the defining of real-world problems in the DT team projects provides the teams with a more analytical lens through which they can construct meaning as they define the problem within the greater context of society as described by Bassin et al. (2020) who encourage clinicians, designers, and architects to collaborate in order to "solve health care's greatest challenges" (p. 326).

Also, the importance of different perspectives and the usefulness of individual skills as reported by students resonate with Vygotsky's approach to social constructivist theory through ZPD (Lantolf, 2000; Nassaji & Cumming, 2000; Marchenkova, 2005). By working in teams to solve a problem using DT, students were provided the opportunity to learn from their peers' experiences. Concerning the importance of exposure to different perspectives, the value of the personal experience of one student (cited in student 15's reflection) with difficulty accessing physiotherapy sessions gave her team members deeper insights into the nature of the problem the team was attempting to define. As a result, the team members were able to learn more about the nature of the problem from various perspectives, a task which individual students may not have been able to accomplish had they attempted to define and solve the problem individually.

Further benefits of the social constructivist approach to problem solving presented by DT include the sharing of individual skills among group members, which facilitates the introduction to and learning of new skills among group members. As DT requires a collaborative approach to problem solving, the sharing of individual technical skills

like designing surveys and video editing among group members contributes to exposing other group members to the requisite skills while giving them a context wherein these skills could be utilized now and in the future.

From an instructional perspective, DT can be considered an innovative approach to teaching because it creates opportunities for active learning where students are fully engaged in the learning process through case studies reading, group discussions, creative thinking, and problem-solving.

Students seem to realize the ultimate aim of DT as a human-centred approach to problem solving where patient experiences and values are important in making any health-related decision. Introducing students to data collection methods and encouraging them to use qualitative tools (openHPI, 2018), such as observing, surveying, or interviewing people to better understand the problem, opened their eyes to new perspectives that they need to take into consideration in their future practice. Wolcott et al. (2020) consider that through observation and communication with the users, students build empathy, an essential human element in DT as well as in healthcare. With the latest advancements in medicine and the use of artificial intelligence, or when faced with the limitations of the current medical system and issues of social inequity, DT presents us with an opportunity to provide equitable healthcare (Davis, 2018; Kim et al., 2017) driven by patient needs.

Finally, using technology for online and blended learning to develop students' knowledge about DT has also encouraged students to leverage technology to design solutions for everyday problems. Therefore, technology has fostered innovative teaching and allowed the implementation of a DT unit as a promising teaching approach that can be further developed to make future healthcare professionals more patient-centred.

7. Conclusion

It is apparent that introducing DT to foundation students in a premedical curriculum created some challenges, yet it also provided positive outcomes that were acknowledged and appreciated by a majority of the students. From a programme improvement perspective, the aim of this paper was to evaluate the newly introduced DT unit that was designed and implemented in an effort to engage students in teamwork, build a community of learners among remote students, and encourage critical thinking and creativity, while improving students' communication skills and their overall EAP skills.

Adopting a technology enhanced learning approach, the DT project was designed and delivered using a mix of online and live sessions to present each phase of the project - *Discover*, *Define*, *Develop*, and *Deliver*. Canvas was used to host the online content covered during the live sessions such as presentations as well as additional materials like readings and YouTube videos that would provide extra information for students to use while preparing their final projects. Students presented their projects live, in a class setting; however, their reflections were posted on Canvas. Communication between the instructors and the students took place mainly online during live Zoom sessions and on Canvas, while communication among students took place using informal social media platforms such as WhatsApp and Google Docs to complete the project.

One of the limitations of this study is the absence of the prototyping phase which limited students' creative endeavours to a minimum. In fact, due to Covid-19 restrictions, students were not able to access a lab space or a makerspace to build a prototype of their solution and test it. Future DT projects should ensure that this phase is implemented to provide students with an end product that they can showcase, test, reflect upon, and even commercialize. Nevertheless, students were thoroughly engaged throughout the DT experience and recognized the importance of teamwork and collaboration and the opportunity for creativity. Students were also able to see the important role that the human-centred approach plays in innovation and how it can be applied to real-world scenarios. Be it face-to-face or online, these values prove to be the same. Students' positive views of the value that DT brings to their everyday lives and its potential role in their future careers encourage us to revise the DT unit framework taking into consideration the challenges the students faced to create a favourable and engaging learning opportunity for future classes. We hope that this paper provides a foundation for other EAP faculty, healthcare educators, and undergraduate programme administrators who are looking into implementing innovative, human-centred, and engaging educational approaches.

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Appendix A. List of essential and optional readings

Essential Readings Source Type	**Title**
YouTube Video	VanGenderen, S. (2014, April 4). *What is design thinking?* [Video]. YouTube. https://youtu.be/a7sEoEvT8l8
Website	Ignite. (n. d.). *Resources*. Ignite: Design thinking and making in arts and sciences. https://ignite.acdh.oeaw.ac.at/resources
Article	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. doi:10.1080/0142159X.2017.1399203
Book Chapter	Nusem E., Straker K., & Wrigley C. (2020). Medical design: The design and development of products for health or medical purposes. In E. Nusem, K. Straker, & C. Wrigley (Eds.), *Design innovation for health and medicine* (pp.17-21). Palgrave Macmillan. https://doi.org/10.1007/978-981-15-4362-3_1
Article	Cohen, A. K., & Cromwell, J. R. (2020). How to respond to the Covid-19 pandemic with more creativity and innovation. *Population Health Management*. doi: 10.1089/pop.2020.0119
Article	Thakur, A., Soklaridis, S., Crawford, A., Mulsant, B., & Sockalingam, S. (2020). Using rapid design thinking to overcome Covid-19 challenges in medical education. *Academic Medicine, 96*(1):56-61. doi:10.1097/ACM.0000000000003718
Article	Koomans, M, & Hilders, C. (2017). Design-driven leadership for value innovation in healthcare. *Design Management Journal, 11*(1), 43-57.
Optional Readings Source Type	**Title**
Book	Knapp, J., Zeratsky, J., & Kowitz, B. (2016). *Sprint: How to solve big problems and test new ideas in just five days*. Random House.
Article	Qoronfleh, M.W., Chouchane, L., Mifsud, B., Al Emadi M, & Ismail, S. (2020). The Future OF Medicine, healthcare innovation through precision medicine: Policy case study of Qatar. *Life Sciences, Society and Policy 16*(12). https://doi.org/10.1186/s40504-020-00107-1
Book Chapter	Nusem E., Straker K., & Wrigley C. (2020) Design outcomes in health and medicine. In E. Nusem, K. Straker, & C. Wrigley (Eds.), *Design innovation for health and medicine* (pp.17-21). Palgrave Macmillan. https://doi.org/10.1007/978-981-15-4362-3_3
Article	Deitte, L. A., & Omary, R. A. (2019). The power of design thinking in medical education. *Academic Radiology, 26*(10), 1417–1420. https://doi.org/10.1016/j.acra.2019.02.012