frontiers | Frontiers in Education

TYPE Original Research
PUBLISHED 02 June 2023
DOI 10.3389/feduc.2023.1172814

OPEN ACCESS

EDITED BY
Rosemary M. Caron,
University of New Hampshire,
United States

REVIEWED BY
Nancy Wingo,
University of Alabama at Birmingham,
United States
Stacy Grau,
Texas Christian University, United States

*CORRESPONDENCE
Jacqueline E. McLaughlin
✉ Jacqui_mclaughlin@unc.edu

RECEIVED 23 February 2023
ACCEPTED 19 May 2023
PUBLISHED 02 June 2023

CITATION
McLaughlin JE, Lake D, Chen E, Guo W, Knock M and Knotek S (2023) Faculty experiences and motivations in design thinking teaching and learning.
Front. Educ. 8:1172814.
doi: 10.3389/feduc.2023.1172814

Faculty experiences and motivations in design thinking teaching and learning

Jacqueline E. McLaughlin[1]*, Danielle Lake[2], Elizabeth Chen[3], Wen Guo[4], McKenna Knock[1] and Steve Knotek[5]

[1]Center for Innovative Pharmacy Education and Research, University of North Carolina Eshelman School of Pharmacy, Chapel Hill, NC, United States, [2]Center for Design Thinking, Elon University, Elon, NC, United States, [3]Department of Health Behavior, University of North Carolina Gillings School of Global Public Health, Chapel Hill, NC, United States, [4]Department of Art, Elon University, Elon, NC, United States, [5]School of Education, University of North Carolina at Chapel Hill, Chapel Hill, NC, United States

Introduction: Design thinking (DT) is a creative, iterative approach to generating solutions that are desirable, feasible, and viable. Given its role in fostering creativity and innovation, a growing number of higher education instructors are teaching DT. Exploring how and what instructors know about DT and why they might teach it could provide critical insight into the ways in which DT is operationalized in higher education teaching and learning.

Materials and methods: A convergent parallel mixed methods design was used for data collected from online surveys administered to faculty teaching DT. The survey included items about DT practices, outcomes from DT, demographic characteristics, and course characteristics. Five open-text survey items queried participants about their definition of DT, why they teach DT, and what additional outcomes they observed. Descriptive statistics were used to analyze quantitative items and thematic analysis was used to analyze qualitative items.

Results: Participants (n=49) represented various academic ranks, disciplines, types of institutions, and geographic locations. Analyses indicated clear congruence between quantitative and qualitative data. Definitions of DT aligned with well-known models of DT. Motivations for teaching DT included the promotion of personal development, DT proficiency, impact, and interpersonal skill development. Other positive student outcomes observed included increases in enthusiasm, self-awareness, empowerment, optimism, and a sense of belonging. Negative student outcomes included time constraints, teamwork conflicts, and student frustration.

Conclusion: Faculty believe that DT leads to highly valuable social innovation skill sets for students. This cross-institutional, multi-disciplinary study provides critical insight into faculty experiences and motivations for teaching DT, offering various strategies for instructors and institutions interested in fostering the uptake of DT within higher education.

KEYWORDS

design thinking, pedagogy, faculty, higher education, mixed methods

Introduction

In recent years, numerous scholars, practitioners, and government agencies have drawn attention to the increasingly complex issues facing society (Stroh, 2015; Baruch, 2017; OECD, 2018b). Many governments, for example, are facing unprecedented economic and societal challenges (OECD, 2018a). Individuals must be prepared for rapid economic, environmental and social changes, including technologies that have not yet been invented and social problems that have not yet been anticipated (OECD, 2018b). Ongoing concerns about our ability to address these increasingly complex social problems have prompted calls for strategies that better equip college graduates to identify and implement effective solutions.

Design thinking (DT), sometimes referred to as human-centered design, is one specific and possible response to these social challenges. DT is a creative problem-solving approach for generating solutions that are desirable, feasible, and viable. The DT process aims to ensure that problems are well-defined and addressed through iterative engagements with stakeholders. Various DT models exist, including IDEO's three-space model (i.e., inspiration, ideation, implementation), Stanford d.School's five hexagons (i.e., empathize, define, ideate, prototype, test), and Creative Reaction Lab's Equity-Centered Community Design phases (i.e., inviting diverse co-creators, building humility + empathy, defining + assessing topic/community needs, ideating approaches, rapid prototyping, and testing + learning) (Creative Reaction Lab, 2022; IDEO, 2022; Stanford d.School, 2022). Some posit that DT can overcome limitations of other problem-solving models by facilitating divergent thinking, embracing ambiguity, and fostering creative confidence (e.g., Kelley and Kelley, 2013; van de Grift and Kroeze, 2016; Panke, 2019; Wolcott and McLaughlin, 2020; Lake et al., 2021; Lake et al., 2023).

DT, and its role in fostering creativity and innovation, has garnered considerable attention in K-12 education (e.g., Katehi et al., 2009; Honey et al., 2014). It has been lauded as an integral cognitive process involving creation, experimentation, and evaluation with relevance across numerous subjects (Razzouk and Shute, 2012). Kelly and Cunningham (2019), for example, described unique ways to support K-12 students' collaborative sense-making, reasoning with evidence, and assessing knowledge in engineering design while Li et al. (2019) advocated for idea generation and design thinking processes in mathematics education.

In higher education, a growing number of educators are teaching DT to help students more collaboratively and creatively address society's increasingly ambiguous and complicated issues. While DT has historically been taught in collegiate disciplines related to business, engineering, and design (e.g., Wrigley and Straker, 2017), recent uptake has been seen in other disciplines, including education (e.g., Lake et al., 2018; Panke, 2019), leadership (e.g., Lake et al., 2019), and health sciences (e.g., McLaughlin et al., 2019; Wolcott et al., 2021; Skywark et al., 2022), among others. Faculty in medicine and public health, for example, have integrated DT into their curricula and partnered with design firms to better understand behavior in clinical settings (Carlisle and Ku, 2016; Ku et al., 2016; van de Grift and Kroeze, 2016; Niccum et al., 2017; Skywark et al., 2022). In the liberal arts, Miller (2017) suggested that "Design thinking that took the past more seriously could provide a framework in which humanists and scientists could work together on problems that need to be understood and even solved, such as climate, food, poverty, health, transportation, or built environments" (pg. 8).

DT has been operationalized within higher education courses using a diverse set of tools and processes, or "DT practices." These practices support the DT process and focus on understanding and creating user-centered solutions, such as doing user research, focusing the problem definition from the user's perspective, emphasizing active learning, getting feedback from users on the protype, and executing real world experiments to test ideas (Liedtka and Bahr, 2019; McLaughlin et al., 2022). In addition, educators have observed various outcomes from teaching DT – or "DT Outcomes," including quality of solutions generated, individual adaptability and flexibility, and psychological benefits (McLaughlin et al., 2022). McLaughlin et al. (2022) also provided validity evidence for DT teaching and learning (DT-TL), demonstrating unique aspects of DT as an educational construct.

Although DT practices and outcomes have been previously described in higher education, DT pedagogy is incompletely understood - particularly in fields beyond traditional design disciplines (i.e., *de-disciplined design*). While it is known that faculty draw from various DT models (e.g., IDEO), how educators define DT within the context of their teaching remains underdescribed (McLaughlin et al., 2022). Further, educators who teach DT in higher education do so for a variety of reasons (e.g., Deitte and Omary, 2019) – yet, their hopes and motivations for teaching DT have not been explored in the context of DT-TL practices and outcomes.

Exploring how and what instructors know about DT and why they might teach it could provide critical insight into the ways in which DT is operationalized in higher education teaching and learning. Therefore, the purpose of this study was to describe DT definitions and motivations as it relates to the DT practices and outcomes that college educators experience in their courses.

Materials and methods

We utilized a convergent parallel mixed methods design that combined quantitative and qualitative data collected from online surveys administered to faculty teaching DT between fall 2020 and spring 2022 (Creswell and Clark, 2017). The survey was adapted from Liedtka and Bahr (2019), who studied DT within for-profit, non-profit, and government sectors (Jaskyte and Liedtka, 2022). Survey items were revised by the research team to align with the context of higher education. The final survey included quantitative items about DT practices, outcomes from DT, demographic characteristics (e.g., *What is your gender identity*?), and course characteristics (e.g., *Was the term "design thinking" explicitly referenced in the course?*). All DT practices and outcomes items used the stem: *Please note how often, as a direct result of this specific course, you observed the following [practices/outcomes]:* and were measured on a scale from 1-Never to 5-Almost Always. In addition, five open-text survey items queried participants about their definition of DT used in their courses, why they teach DT, what they hope for students to take from the course, what additional positive outcomes they observed, and any negative student outcomes observed.

Purposive sampling was used to identify and recruit participants based on their experience teaching DT in United States (U.S.) higher education (Schutt, 2006). Participants were recruited via emails to

professional contacts, listservs, and networks. Due to the nature of the listservs and overlap between recruitment sources, a response rate could not be determined. The email included a description of the study and a link to the survey. Survey items measured quantitively were analyzed using descriptive statistics. Median and interquartile range (IQR) were used for ordinal variables, and frequency (percent) for categorical variables. Item reliabilities were calculated using Cronbach alpha (α). Open text survey items were analyzed using inductive coding by a single coder. Two open-text survey items resulted in the same codes and were subsequently aggregated (*Why do you explicitly teach design thinking?* and *What is your hope for students after they take your design thinking course?*). The research team reviewed all codes together and refined them as needed. In the final stage of analysis, quantitative items were mapped to qualitative themes as a means to support and provide further insight into the findings. This integration of quantitative and qualitative items elucidated alignment between the different types of data and enabled complementarity, which elaborates, enhances, and clarifies results and increases interpretability and validity of findings (Creswell and Clark, 2017). All analyses were completed in Microsoft Excel.

This project was submitted to the Institutional Review Boards at UNC (#20-2,316), Elon University (#21-031), Duke Campus (#2021-0168), and North Carolina State University (#23502). The submission was approved or determined to be exempt from further review by each review board according to 45 CFR 46.104. Written consent was obtained electronically from all participants at the start of the survey.

Results

Forty-nine participants completed the survey. Most were White ($n = 34$, 69.83%), Not Hispanic or Latino or Spanish Origin ($n = 41$, 83.67%), and female (31, 63.27%) (Table 1). They represented a wide variety of disciplines, including Arts and sciences ($n = 13$, 26.53%), Design ($n = 7$, 14.28%), Engineering ($n = 6$, 12.24%), and other disciplines such as Business, Health Sciences, Government, Communication, and Education. About half of the participants were from privately controlled schools ($n = 29$, 59.18%). Participants were from various types of institutions per U.S. Carnegie Classifications of Institutions of Higher Education, such as Research I institutions ($n = 24$, 48.97%) and Special Focus institutions ($n = 7$, 14.28%), and they represented various academic ranks, including Professor ($n = 18$, 36.73%), Associate Professor ($n = 9$, 18.37%), and Assistant Professor 13, 26.53%). Geographically, participants represented institutions from the Southeast ($n = 28$, 57.14%), Northeast ($n = 8$, 16.32%), Midwest ($n = 5$, 10.20%), Southwest ($n = 3$, 6.12%), and other (e.g., international) ($n = 3$, 6.12%).

Participants had differing types of formal DT training (e.g., certificate, course, workshop) and informal DT training (e.g., reading, consultation with experts), and varying years of experience, ranging from less than 1 year ($n = 4$, 8.16%) to more than 10 years ($n = 10$, 20.41%). Most participants indicated experience with the Stanford d.school ($n = 29$, 59.18%), IDEO ($n = 28$, 57.14%), and Design Justice ($n = 10$, 20.41%) models of DT. Time teaching DT ranged from less than 1 year ($n = 10$, 22.73%) to more than 10 years ($n = 8$, 18.18%). Most agreed that their course explicitly used the term DT ($n = 40$, 85.11%), had the resources needed for the course ($n = 37$, 80.43%), and that the physical space provided was conducive to learning ($n = 32$, 71.11%). Course enrollments ranged from 3 to 400, averaging 38.04 ± 65.95 students with teamwork comprising 65.27% ± 27.29% of the course time.

TABLE 1 Faculty demographics and design thinking background ($N = 49$).

Demographic	Response option	*n* (%)
Gender	Female	31 (63.27)
Race	White	34 (69.83)
	Asian	6 (12.24)
	Black or African American	4 (8.16)
	Prefer not to say	4 (8.16)
Ethnicity	Not Hispanic or Latino or Spanish origin	41 (83.67)
Discipline*	Arts and sciences	13 (26.53)
	Business	3 (6.12)
	Design	7 (14.28)
	Engineering	6 (12.24)
	Health sciences	5 (10.20)
	Other (e.g., Communication, education, government)	17 (34.69)
Academic rank	Professor	8 (16.32)
	Associate professor	10 (20.41)
	Assistant professor	13 (26.53)
	Other (e.g., lecturer, staff, postdoctoral fellow)	18 (36.73)
Training in design thinking*	I received a degree	9 (18.37)
	I received a certification	3 (6.12)
	I attended an in-person course	18 (36.73)
	I attended an online course	9 (18.37)
	I attended an in-person workshop or training	18 (36.73)
	I did readings	37 (75.51)
	I held conversations or consultations with experts	31 (63.27)
	I worked on a project that used design thinking	22 (44.90)
	Other	10 (20.41)
Years practicing DT	Less than 1 year	4 (8.16)
	2–3 years	9 (18.37)
	4–6 years	18 (36.73)
	7–10 years	8 (16.32)
	More than 10 years	10 (20.41)
Years teaching DT	Less than 1 year	10 (20.41)
	2–3 years	12 (24.49)
	4–6 years	13 (26.53)
	7–10 years	1 (2.04)
	More than 10 years	8 (16.32)

DT, design thinking.
*Participants selected multiple responses; therefore, sum may exceed 100%.

DT practices and outcomes

Table 2 provides the median and IQR for survey items. The most frequently observed DT practices included: *Emphasized active listening among team members in order to find shared meaning* (4.00, 1.00); *Created a set of design criteria based on research (*e.g.*, prioritized criteria for success)* (4.00, 1.00); *Generated a diverse set of ideas based on design criteria* (4.00, 1.00); and *Created prototypes of your ideas (*e.g.*, storyboards, videos, mock-ups of offerings)* (4.00, 1.00). Faculty least frequently *Moved multiple ideas into prototyping and testing* (3.00, 1.00). The DT practice items demonstrated high internal reliability ($\alpha = 0.86$).

As it relates to outcomes of DT, faculty most frequently observed that their course *Helped see problems in new ways, resulting in solving more promising problems* (4.00, 0.00), *Built trust among team members* (4.00, 0.00), *Helped people connect and support each other* (4.00, 0.00), *Encouraged people's open-mindedness to try new things* (4.00, 0.00), *Kept people motivated to work on a project to achieve*

TABLE 2 Design thinking practices and outcomes observed by faculty (N=49).

Survey item*	
DT practices	Median (IQR)
1. Worked in teams that recognized diverse contributions	4.00 (2.00)
2. Emphasized active listening among team members in order to find shared meaning	4.00 (1.00)
3. Engaged in ethnographic tools or empathy/inspiration exercises/activities with others that may be impacted by our project	4.00 (2.00)
4. Identified a problem definition based on people's perspectives rather than on theory or organizational perspectives alone	4.00 (2.00)
5. Created a set of design criteria based on research (e.g., prioritized criteria for success)	4.00 (1.00)
6. Generated a diverse set of ideas based on design criteria	4.00 (1.00)
7. Created prototypes of your ideas (e.g., storyboards, videos, mock-ups of offerings)	4.00 (1.00)
8. Moved multiple ideas into prototyping and testing	3.00 (1.00)
9. Executed real world experiments to test your ideas	4.00 (3.00)
DT outcomes	
1. Helped see problems in new ways, resulting in solving more promising problems	4.00 (0.00)
2. Enhanced ability to pivot when initial solution did not work	4.00 (1.00)
3. Built new relationships locally that continued after the initial project was completed	3.00 (2.00)
4. Expanded access to new resources for individuals and teams	4.00 (1.00)
5. Helped pool resources for greater impact	3.00 (1.00)
6. Enhanced other stakeholders willingness to collaborate on new solutions	3.00 (2.00)
7. Built trust among team members	4.00 (0.00)
8. Built trust between problem-solving teams and other stakeholders	4.00 (1.50)
9. Allowed new and better solutions, not visible at the beginning of the process, to emerge during it	4.00 (0.25)
10. Fostered the inclusion of input from stakeholders	4.00 (1.00)
11. Helped people involved to examine their own biases and preconceptions	4.00 (0.25)
12. Created a sense of safety for students to try new things	4.00 (1.00)
13. Gave people more confidence in their own creative abilities	4.00 (1.00)
14. Improved the likelihood of the implementation of new solutions	4.00 (1.00)
15. Made it easier to discard solutions that did not work as planned	4.00 (1.00)
16. Helped people connect and support each other	4.00 (0.00)
17. Encouraged people's open-mindedness to try new things	4.00 (0.00)
18. Encouraged shifts in culture that made it more people-focused	4.00 (1.00)
19. Encouraged changes in the culture that made risk-taking more acceptable	4.00 (1.50)
20. Kept people motivated to work on a project to achieve impact	4.00 (0.00)
21. Broadened understanding of what innovation is	4.00 (1.00)
22. Increased students' sense of ownership and acceptance of a solution	4.00 (1.00)
23. Increased appreciation for use of data to help drive decisions	4.00 (1.00)
24. Increased engagement of teammates involved in the design thinking process	4.00 (0.00)

IQR, interquartile range.
*Item followed the stem, please note how often, as a direct result of this specific course, you observed the following outcomes and were measured on a scale from 1-Never to 5-almost always. $\alpha = 0.86$ (DT practices) and $\alpha = 0.92$ (DT outcomes).

impact (4.00, 0.00), and *Increased engagement of teammates involved in the design thinking process* (4.00, 0.00). Outcomes least frequently observed included *Built new relationships locally that continued after the initial project was completed* (3.00, 2.00) and *Enhanced other stakeholders willingness to collaborate on new solutions* (3.00, 2.00). The outcomes of DT also demonstrated high internal reliability ($\alpha = 0.92$).

DT definitions and motivations

Five prominent themes emerged from analyzing *faculty participants' definitions of DT*: (1) human centered process, (2) systematic approach, (3) creative problem solving, (4) collaboration, and (5) mindset (Table 3). All five themes aligned with survey items related to DT practices. The understanding of DT as a human centered process, for example, encompassed definitions and phrases focused on the experiences and needs of others. For instance, one participant from the discipline of Design said DT is, "*a process that allows you to research a phenomenon, utilizing the experiences of those being directly affected by the issue.*" Similarly, participants indicated on the survey that students frequently *Engaged in ethnographic tools or empathy/inspiration exercises/activities with others that may be impacted by our project* (4.00, 2.00).

Participants from various disciplines described DT as a systematic approach and noted numerous DT processes, such as "*framing, exploring, generating, prototyping and cultivating,*" "*framing and solving ambiguous problems,*" "*inspiration, ideation, and implementation,*" "*a set of facilitation techniques,*" and "*an iterative process.*" Survey responses indicated that participants frequently observed systematic DT practices, such as *Generated a diverse set of ideas based on design criteria* (4.00, 1.00).

When participants explicated creative problem solving in their definition of DT, they contextualized the need for creativity by describing problems as *"ambiguous," "wicked," "challenges," "issues,"* and *"real-world."* On the survey, participants also frequently observed that students *Generated a diverse set of ideas based on design criteria* (4.00, 1.00). Similarly, the collaboration and mindset themes were apparent in the DT practices survey items, such as *Worked in teams that recognized diverse contributions* (4.00, 2.00) and *Emphasized active listening among team members in order to find shared meaning* (4.00, 1.00).

When asked *why they teach DT and what they hope for students after the course,* participants emphasized desires for students': (1) personal development, (2) DT proficiency, (3) impact, and (4) interpersonal skill development (Table 4). These themes also all aligned with survey items related to outcomes of DT. Personal development, for example, was characterized more specifically by subthemes such as creative development, empowerment, and mindfulness. As noted by one participant from Communications, *"I hope students learn to be mindful of their creative processes and learn from DT how being informed and reflective of one's process could be enriching and helpful."* Participants also indicated on the survey that teaching DT *Helped people involved to examine their own biases and preconceptions* (4.00, 0.25) and *Gave people more confidence in their own creative abilities* (4.00, 1.00).

Participants also touted the importance of DT proficiency by explicating the importance of DT knowledge and application, as a participant from Management described that it *"provides a process and way of understanding the world to create, [and] can be scaled and applied in many contexts"* Survey items indicated that participants frequently observed that DT *Helped see problems in new ways, resulting in solving more promising problems* (4.00, 0.00) and *Broadened understanding of what innovation is* (4.00, 1.00).

Participants described their hope for students to enact positive change and impact after the course by *"designing a more just world," "creating positive change," "address[ing] wicked problems,"* and "*build[ing] their capacities to address the challenges we are facing in the world today."* These elements were also apparent in survey items, such as *Helped people involved to examine their own biases and preconceptions* (4.00, 0.25) and *Encouraged people's open-mindedness to try new things* (4.00, 0.00).

Participants also emphasized the importance of collaboration and empathy as interpersonal skills, such as hoping students "*work collaboratively [and] learn to solicit user feedback in their work.*" Numerous survey items also addressed interpersonal skills, with participants frequently observing that their course *fostered the inclusion of input from stakeholders* (4.00, 1.00), *helped people connect and support each other* (4.00, 0.00), and *increased engagement of teammates involved in the design thinking process* (4.00, 0.00).

TABLE 3 Thematic results regarding definitions of DT taught in class (N=59 codes).

Theme	Example quote	Example related survey items
Human centered process (n = 19, 32.3%)	*A process that allows you to research a phenomenon, utilizing the experiences of those being directly affected by the issue*	DTP3 (Engaged in ethnographic tools or empathy/inspiration exercises/activities with others that may be impacted by our project)
Systematic approach (n = 18, 30.5%)	*A methodology for problem solving through phases of inspiration, ideation, and implementation*	DTP5 (Created a set of design criteria based on research) DTP7 (Created prototypes of your ideas)
Creative problem solving (n = 13, 22.0%)	*A way to creatively understand and address ambiguous challenges*	DTP6 (Generated a diverse set of ideas based on design criteria)
Collaboration (n = 5, 8.5%)	*to collaboratively and iteratively develop meaningful… solutions*	DTP1 (Worked in teams that recognized diverse contributions) DTP2 (Emphasized active listening among team members in order to find shared meaning)
Mindset (n = 4, 6.8%)	*…designerly ways of knowing*	DTP4 (Identified a problem definition based on people's perspectives rather than on theory or organizational perspectives alone)

DTP, design thinking practice survey item.

TABLE 4 Thematic results regarding why faculty teach DT (*N*=130 codes).

Theme	Subthemes	Example quote	Example related survey items
Personal development (*n* = 45, 34.6%)	Creative development, empowerment, perspective building, mindfulness, professional development	*So that they feel an increased sense of self-efficacy and creative confidence.*	DTO11 (Helped people involved to examine their own biases and preconceptions) DTO13 (Gave people more confidence in their own creative abilities)
DT proficiency (*n* = 37, 28.5%)	DT knowledge, continued application	*So that students develop the skills, tools, and mindsets that will help them in their entrepreneurial path both in organizations they start or join, as well as in their personal life.*	DTO1 (Helped see problems in new ways, resulting in solving more promising problems)
Impact (*n* = 27, 20.8%)	Create change, solve complex problems	*To build power toward those at the margins.*	DTO14 (Improved the likelihood of the implementation of new solutions)
Interpersonal skills (*n* = 21, 16.2%)	Collaboration, empathy	*…that they realize the value in listening to their peers, colleagues and customers.*	DTO7 (Built trust among team members) DTO10 (Fostered the inclusion of input from stakeholders) DTO16 (Helped people connect and support each other) DTO24 (Increased engagement of teammates involved in the design thinking process)

DTO, design thinking outcome survey item.

Additional outcomes observed

When asked to *Please list any other positive student outcomes you observed from the use of design thinking practices that were not discussed here,* participants included enthusiasm, self-awareness, empowerment, integration of content with other courses, fostering optimism, and creating a sense of belonging. When asked to *Please list any negative student outcomes you observed from the use of design thinking practices,* participants noted time constraints (e.g., *"Not having adequate time to fully follow through with the design thinking process"),* teamwork conflicts, student frustration (e.g., *"Some students can find it very hard to let go of their biases, and trust the process."),* and underperformance (e.g., *"Not performing up to demonstrated potential, desired outcomes, or did not fully grasp the DT process").*

Discussion

This research contributes to a small yet growing body of research exploring de-disciplined DT-TL in higher education. Although scholars have described various uses and outcomes of DT in higher education, few have explored the perceptions, experiences, and motivations of those teaching DT across disciplines (e.g., McLaughlin et al., 2022). In general, our study suggests that faculty use common definitions of DT in their courses, observe numerous DT practices and outcomes, and invoke varying motivations for teaching DT to students.

Notably, definitions of DT provided by participants in this study aligned with widely recognized DT models. While not surprising given participant DT training (e.g., Stanford d.school, IDEO, Design Justice), it confirms that students across disciplines and institutions are learning similar, core DT constructs. Namely, faculty are teaching DT as a creative, human-centered problem-solving approach that is systematic, collaborative, and dependent on mindset. While this has been described within single disciplines (e.g., Deitte and Omary, 2019), our study provides evidence that students of different levels and disciplines are being equipped with similar DT knowledge, offered similar DT practices, and experiencing similar DT outcomes.

While DT definitions tended to converge with common frameworks, faculty motivations for teaching DT varied. These motivations provide critical insight into the benefits that faculty believe DT-TL might offer students, graduates, universities, communities, and employers. Some opined the value of DT proficiency and their hopes for fostering positive impacts on society and communities. Others elucidated the personal development and interpersonal skills they hoped to promote in students. Taken together, participants clearly posited the benefits of DT as motivation for DT-TL. However, these varied motivations warrant further study, as understanding them better could position institutions to promote the uptake of DT -TL as they work to equip students for the workforce.

Notably, there is increasing demand on colleges to help graduates simultaneously master the disciplinary knowledge and mindsets necessary to address complex real-world problems (e.g., Arum and Roksa, 2011; Christensen and Eyring, 2011; Baruch, 2017; Brown et al., 2019). College graduates must develop traditional work and life skills that extend beyond traditional disciplinary knowledge and technical abilities – such as creativity, adaptability, and empathy (e.g., Wagner, 2010; McLaughlin et al., 2017; 2019); however, the challenges associated with helping students develop these skills are widely recognized. In our study, participants observed students using these types of skills – some of them frequently – and noted the development of these skills as specific motivators for teaching DT. Participants also observed highly valuable outcomes (e.g., increased enthusiasm, and self-awareness, stronger bonds between team members, etc.) that have been found to be significant for sustaining social innovation efforts (Waitzer and Paul, 2011; Kania et al., 2018). Thus, our study provides support - from the perspective of those in this study - that DT may facilitate the development of critical personal, professional, and civic skills commonly seen as essential, yet challenging to instill in students.

Our findings also underscore the potential for DT-TL to promote transformative learning, defined as the process by which we transform problematic frames of reference – such as mindsets - to be more inclusive, reflective, and open (Mezirow, 2018). DT practices can help students experience transformative learning by offering tools and methods for them to engage in critical self-reflection on their bias and

preconceptions of wicked problems to solve - an outcome observed by faculty in this study. In addition, the ability of DT practice to cultivate empathy may provide more motivation for students to better listen and understand perspectives and emotions of others and their own (Taylor, 2017). In a review of DT in education, Panke (2019) concluded that: "Taking part in design thinking activities can be a transformative experience of amazement, camaraderie and joyful discovery. We documented characteristics particularly meaningful in a pedagogical setting: tacit experiences, increased empathy, reduced cognitive bias, playful learning, flow, verve, inter/meta-disciplinary collaboration, productive failure, resilience, surprising solutions, and creative confidence" (pg. 301).

The results of our study also point to potential areas of opportunity for DT-TL. Faculty least frequently observed students to *move ideas into prototyping and testing*, and yet iterative prototyping and testing are critical for generating viable and valuable project outcomes and for yielding more transformative learning (Liedtka and Bahr, 2019; Kuhn, 2021; Lake et al., 2022). By requiring students to more frequently prototype and test their ideas with project stakeholders, faculty could build external relationships for students that support their future professional, personal, and civic goals; they could also be enhancing external stakeholder willingness to collaborate on student projects that may yield benefit for surrounding communities. Indeed, work by Lake et al. (2019) suggests that DT can empower college students to design desirable, feasible, transdisciplinary solutions that promote practical and sustainable outcomes. To enable more prototyping and testing, educators should consider separate courses dedicated to building prototyping skills as it may be too much to include in a single semester-long course.

Similarly, a number of the least frequently observed outcomes, including *Built new relationships locally that continued after the initial project was completed* and *Enhanced other stakeholders willingness to collaborate on new solutions,* suggest that community engagement is generally limited in DT-TL. This may be influenced by the barriers and challenges of traditional academic structures and cultures, including semester-bound courses, discipline-specific learning outcomes, lack of incentives for community engagement, and university hierarchies (Lake et al., 2021). Identifying strategies for improving these outcomes could be an important advancement, as some research suggests that DT can help students move beyond traditional research skills by generating relevant projects in and with communities (Crouch and Pearce, 2013; Fernaeus and Lundström, 2015; Miller, 2017; Lake et al., 2018).

Furthermore, the participants in this study are likely using DT because of their beliefs regarding its benefits. These beliefs are clearly reflected in the high and relatively stable survey ratings: college educators who believe in the merits of DT are likely to observe – or perceive the use of - those DT benefits when they teach DT. This underscores the need for objective measures of DT impact on student learning and research that more fully interrogates the processes that college educators use to integrate their beliefs about DT into their instructional design. Understanding the ways in which DT educators operationalize their beliefs into their teaching practice – and the resulting impact on student learning - could elucidate opportunities for research into educator development for DT teaching.

This study has a number of limitations. First, we recruited faculty using purposive sampling, which may have introduced selection bias. Second, this study was descriptive in nature, and was unable to assess the effectiveness of different DT-TL pedagogies. Third, data reflected faculty perceptions at the end of a course, leaving the long-term impact of DT-TL unknown. Fourth, the study – including the literature and sample – are situated within North America, which may influence DT perspectives, assumptions, and models. That being said, our results are not meant to be generalizable to all DT courses across all higher education institutions. Rather, they provide an important glimpse into DT-TL across multiple universities and disciplines and identify gaps and opportunities for advancing this critical topic.

DT-TL is a complex construct that requires further study, both within and across higher education disciplines and institutions. Indeed, the application of DT itself is evolving and its impact in higher education remains unrealized. We must continue working to understand the full potential of DT for equipping students with the requisite knowledge and skills needed for resiliently addressing our complex social challenges, and how faculty might be best positioned to teach it.

Data availability statement

The datasets presented in this study can be found in online repositories. The names of the repository/repositories and accession number(s) can be found at: https://www.openicpsr.org/openicpsr/project/185423/version/V1/view.

Ethics statement

The studies involving human participants were reviewed and approved by the Institutional Review Boards at UNC (#20-2316), Elon University (#21-031), Duke Campus (#2021-0168), and North Carolina State University (#23502). The patients/participants provided their written informed consent to participate in this study.

Author contributions

JM, DL, EC, WG, and SK contributed to conception and design of the study. JM and MK organized the database, performed the analyses, and wrote the first draft of the manuscript. DL, EC, and WG wrote sections of the manuscript. All authors contributed to manuscript revision and read and approved the submitted version.

Acknowledgments

We would like to thank the incredible support and generosity of our research participants in sharing their motivations, perceptions, and experiences with us. We would also like to acknowledge the support of our Research Assistants and Design Thinking Fellows who contributed to this study including: Emily Skywark, Megan Casner, Adam Kanowitz, and Trinity Barnett.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

References

Arum, R., and Roksa, J. (2011). *Academically adrift: limited learning on college campuses*. Chicago, IL: University of Chicago Press.

Baruch, J. M. (2017). Doctors as makers. *Acad. Med.* 92, 40–44. doi: 10.1097/ACM.0000000000001312

Brown, V. A., Harris, J. A., and Waltner-Toews, D. (2019). *Independent thinking in an uncertain world: a mind of One's own*. New York, NY: Routledge.

Carlisle, S., and Ku, B. (2016). Mapping the hospital environment: linking occupant behavior and environmental conditions in an acute care setting. Paper presented at: Association of Collegiate Schools of architecture 2016 Annual meeting; September 22–24, 2016; Honolulu, HI. https://www.acsa-arch.org/wp-content/uploads/2016fallconference-printedprogram_online.pdf (Accessed May 24, 2023).

Christensen, C. M., and Eyring, H. J. (2011). *The innovative university: changing the DNA of higher education from the inside out*. Hoboken, NJ: John Wiley & Sons.

Creative Reaction Lab (2022). A method for co-creating equitable outcomes. Available at: https://crxlab.org/our-approach (Accessed January 17, 2023).

Creswell, J. W., and Clark, V. L. P. (2017). Designing and conducting mixed methods research. Washington, DC: Sage Publications.

Crouch, C., and Pearce, J. (2013). *Doing research in design*. New York, NY: Bloomsbury Publishing.

Deitte, L. A., and Omary, R. A. (2019). The power of design thinking in medical education. *Acad. Radiol.* 26, 1417–1420. doi: 10.1016/j.acra.2019.02.012

Fernaeus, Y., and Lundström, A. (2015). Practicing design judgement through intention-focused course curricula. *Des. Technol. Educ.* 20, 47–58.

Honey, M., Pearson, G., and Schweingruber, H. (2014). STEM integration in K-12 education. Prospects, and an agenda for Research. Washington, DC: National Academies of Sciences.

IDEO. (2022). Design thinking. Available at: https://designthinking.ideo.com/ (Accessed January 17, 2023).

Jaskyte, K., and Liedtka, J. (2022). Design thinking for innovation: practices and intermediate outcomes. *Nonprofit Manag. Leadersh.* 32, 555–575. doi: 10.1002/nml.21498

Kania, J., Kramer, M., and Senge, P. (2018). The water of systems of change. Policy commons. Available at: https://policycommons.net/artifacts/1847266/the-water-of-systems-change/2593518/

Katehi, L., Pearson, G., and Feder, M. (2009). *Engineering in K-12 education: understanding the status and improving the prospects*. Washington, DC: National Academies Press.

Kelley, T., and Kelley, D. (2013). Creative confidence: unleashing the creative potential within us all. Currency. New York, NY: Crown Business.

Kelly, G. J., and Cunningham, C. M. (2019). Epistemic tools in engineering design for K-12 education. *Sci. Educ.* 103, 1080–1111. doi: 10.1002/sce.21513

Ku, B., Shah, A., and Rosen, P. (2016). *Making design thinking a part of medical education*. NEJM Catalyst website. Available at: http://catalyst.nejm.org/making-design-thinking-part-medical-education/. (Accessed January 25, 2023).

Kuhn, S. (2021). *Transforming learning through tangible instruction: the case for thinking with things. 1st* Edn New York, NY: Routledge.

Lake, D., Flannery, K., and Kearns, M. (2021). A cross-disciplines and cross-sector mixed-methods examination of design thinking practices and outcomes. *Innov. High. Educ.* 46, 337–356. doi: 10.1007/s10755-020-09539-1

Lake, D., Guo, W., Cox, M., Chen, E., and McLaughlin, J.E. (2023). *De-disciplining and democratizing design thinking pedagogies in higher education*. Teaching and Learning Inquiry. Forthcoming

Lake, D., Lehman, M., and Chamberlain, L. (2019). Engaging through design thinking: catalyzing integration, iteration, innovation, and implementation. *eJournal of Public Affairs* 8, 40–49. doi: 10.21768/8.1.5

Lake, D., Motley, P., Casner, M., and Flannery, K. (2022). Design thinking community health and well-being: creating with and for community capacities. *Design Res. Soc. Proc.* doi: 10.21606/drs.2022.210

Lake, D., Motley, P., and Moner, W. (2021). "Completing the CiCLE: assessing longitudinal ecosystems change to improve community-based and design-centric immersive learning" in *Social Enterprise Journal*. Available at: https://works.bepress.com/danielle_lake/85/ Accessed January 25, 2023

Lake, D., Ricco, M., and Whipps, J. (2018). Design thinking accelerated leadership: transforming self, transforming community. *J. Gen. Educ.* 65, 159–177. doi: 10.5325/jgeneeduc.65.3-4.0159

Li, Y., Schoenfeld, A. H., diSessa, A. A., Graesser, A. C., Benson, L. C., English, L. D., et al. (2019). Design and design thinking in STEM education. *J. Stem. Educ. Res.* 2, 93–104. doi: 10.1007/s41979-019-00020-z

Liedtka, J., and Bahr, K. J. (2019). Assessing design thinking's impact: report on the development of a new instrument (No. 19–13). Darden Working Paper Series.

McLaughlin, J. E., Bush, A. A., Rodgers, P. T., Scott, M. A., Zomorodi, M., Pinelli, N. R., et al. (2017). Exploring the requisite skills and competencies of pharmacists needed for success in an evolving health care environment. *Am. J. Pharm. Educ.* 81:116. doi: 10.5688/ajpe816116

McLaughlin, J. E., Chen, E., Lake, D., Guo, W., Skywark, E. R., Chernik, A., et al. (2022). Design thinking teaching and learning in higher education: experiences across four universities. *PLoS One* 17:e0265902. doi: 10.1371/journal.pone.0265902

McLaughlin, J. E., Minshew, L. M., Gonzalez, D., Lamb, K., Klus, N. J., Aubé, J., et al. (2019). Can they imagine the future? A qualitative study exploring the skills employers seek in pharmaceutical sciences doctoral graduates. *PLoS One* 14:e0222422. doi: 10.1371/journal.pone.0222422

McLaughlin, J. E., Wolcott, M. D., Hubbard, D., Umstead, K., and Rider, T. R. (2019). A qualitative review of the design thinking framework in health professions education. *BMC Med. Educ.* 19, 1–8. doi: 10.1186/s12909-019-1528-8

Mezirow, J. (2018). "Transformative learning theory" in *Contemporary theories of learning*. ed. K. Illeris (New York, NY: Routledge), 116–128.

Miller, P. N. (ed.) (2017). Is "design thinking" the new liberal arts?. In *The evolution of liberal arts in the global age*. (New York, NY: Routledge), 167–173.

Niccum, B. A., Sarker, A., Wolf, S. J., and Trowbridge, M. J. (2017). Innovation and entrepreneurship programs in US medical education: a landscape review and thematic analysis. *Med. Educ. Online* 22:1360722. doi: 10.1080/10872981.2017.1360722

OECD. (2018a). *OECD science, technology and innovation outlook 2018*. Washington, DC: OECD publishing.

OECD (2018b). *The future of education and skills: education 2030*. Washington, DC: OECD Publishing.

Panke, S. (2019). Design thinking in education: perspectives, opportunities and challenges. *Open Educ. Stud.* 1, 281–306. doi: 10.1515/edu-2019-0022

Razzouk, R., and Shute, V. (2012). What is design thinking and why is it important? *Rev. Educ. Res.* 82, 330–348. doi: 10.3102/0034654312457429

Schutt, J. (2006). *Investigating the social world: the process and practice of research. 5th Edn.* Thousand Oaks: Sage.

Skywark, E. R., Chen, E., and Jagannathan, V. (2022). Using the design thinking process to co-create a new, interdisciplinary design thinking course to train 21st century graduate students. *Front. Public Health* 9:2159. doi: 10.3389/fpubh.2021.777869

Stanford d.School. (2022). *Getting started with design thinking*. Available at: https://dschool.stanford.edu/resources/getting-started-with-design-thinking

Stroh, D. P. (2015). *Systems thinking for social change: a practical guide to solving complex problems, avoiding unintended consequences, and achieving lasting results*. White River Junction, VT: Chelsea Green Publishing.

Taylor, E. W. (2017). Critical reflection and transformative learning: a critical review. *PAACE J. Lifelong Learn.* 9, 313–319. doi: 10.12691/education-9-5-9

van de Grift, T. C., and Kroeze, R. (2016). Design thinking as a tool for interdisciplinary education in health care. *Acad. Med.* 91, 1234–1238. doi: 10.1097/ACM.0000000000001195

Wagner, T. (2010). The global achievement gap: why even our best schools don't teach the new survival skills our children need-and what we can do about it. ReadHowYouWant.com. Philadelphia, PA: Basic Books.

Waitzer, J. M., and Paul, R. (2011). Scaling social impact: when everybody contributes, everybody wins. *Innovations* 6, 143–155. doi: 10.1162/INOV_a_00074

Wolcott, M. D., and McLaughlin, J. E. (2020). Promoting creative problem-solving in schools of pharmacy with the use of design thinking. *Am. J. Pharm. Educ.* 84:8065. doi: 10.5688/ajpe8065

Wolcott, M. D., McLaughlin, J. E., Hubbard, D. K., Rider, T. R., and Umstead, K. (2021). Twelve tips to stimulate creative problem-solving with design thinking. *Med. Teach.* 43, 501–508. doi: 10.1080/0142159X.2020.1807483

Wrigley, C., and Straker, K. (2017). Design thinking pedagogy: the educational design ladder. *Innov. Educ. Teach. Int.* 54, 374–385. doi: 10.1080/14703297.2015.1108214