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RESEARCH

Design thinking in North American undergraduate medical education

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SUMMARY

As medical students graduate into an increasingly complex healthcare system, researchers, clinicians, and policy makers have called for novel curricular initiatives. Design thinking is a structured innovation framework used regularly in business and engineering. We surveyed and interviewed design thinking educators in medical schools and mapped key themes to curricular accreditation standards in the US and Canada. Although we found significant program heterogeneity, all programs emphasised skills in problem definition in complex spaces and interdisciplinary collaboration. These skills mapped to key curricular content areas. Standardised outcome-based evaluation of students competencies will help further develop the intersection between design and medical education.

Key Words: Design thinking; human-centered design; Medical education

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ABSTRACT

Background

Calls for innovation in health care have led to novel curricular initiatives in undergraduate medical education. A structured innovation methodology known as design thinking, which prioritises human requirements in complex systems of multiple services, is now being taught in some medical curricula.

Aims

The aim of the study was to present the current state of design thinking education programs in medical schools in the United States (US) and Canada. Our secondary goals were to provide program operational details, describe curricular content and goals, and develop recommendations for integrating design thinking in undergraduate medical education. We sought to align recommendations from the Liaison Committee on Medical Education's (LCME) Standards for the Function and Structure of Medical Schools.

Method

The authors used a sequential explanatory mixed methods approach consisting of an online questionnaire followed by semi-structured interviews. We recruited educators teaching design thinking to medical students at accredited medical schools in the US and Canada to participate in and coauthor the study. We analysed data via descriptive statistics and thematic analysis by researchers and faculty from education institutions in Canada, Mexico, and the US. We mapped results to elements from the LCME accreditation standards.

Conclusion

We noted heterogeneity in program length, trainer credentials, content, student outputs, and evaluation methods. All programs emphasised developing skills in problem definition and collaboration. These objectives aligned with curricular content areas required by the LCME. Educators largely relied on student satisfaction to promote programs to leadership.

Design thinking in undergraduate medical education contributes key curricular content to physicians in training. Standardised outcome-based evaluations of student competencies are needed to determine best practices in pedagogy. Educators with expertise in design, medicine, engineering, and education may consider collaborating to devise better competency-based evaluation methods for problem definition and collaborative practices.

BACKGROUND

Today's medical students are graduating into an increasingly multidimensional healthcare ecosystem characterised by a growing focus on patient experience, value of care, social determinants of health, and novel forms of technology.[1,2] Scholars, clinicians, and policy makers have called for updates to medical school curricula to ensure that graduating students are prepared to work in this changing healthcare landscape.[3–6] Design thinking, with its emphasis on prioritising human needs in complex systems, has emerged as an approach to help medical students be more context-aware in the design and implementation of healthcare delivery innovations.[7–9]

The academic field of design developed in the early 20th century in continental Europe in response to the growing disconnect between producers and consumers prompted by mass production.[10] Design educators began to formalize methods of practice in the mid-1950s, and design moved from production-related skills to a set of methods for identifying which innovations were needed.[11] As design practices continued to be abstracted to professional practices over the course of the second half of the 20th century, design developed into a formal problem-solving epistemology. This evolution culminated in the early 2000s with the coining of the phrase "design thinking", which described a semi-formalised approach to identifying context-specific needs as the basis for generating solutions for intended beneficiaries.[12] The teaching of design thinking has

extended beyond graduate programs in design to business, engineering, and, more recently, health science professions.[13]

Training in design thinking may offer medical students the skills needed for the changing healthcare environment.[7–9,14,15] Symmetries have been drawn between design thinking and medicine, as both approach problem-solving in complex conditions in an iterative, rather than sequential, fashion.[16] Healthcare systems are experimenting with the application of design thinking to care delivery: during the last decade, more than a dozen healthcare systems across the US and Canada have launched interdisciplinary health innovation labs staffed with trained designers.[17] Systematic reviews in 2018 and 2021 identified design thinking interventions applied across a variety of healthcare conditions and specialties with associated improvements in patient safety and quality.[18,19]

Relatively little is known about how design thinking is being integrated into undergraduate medical education, however, and whether this curriculum aligns with current expectations for medical student competencies. To address this gap in knowledge, we employed a sequential explanatory mixed-methods study design to survey and interview individuals involved in medical education, design education, and healthcare delivery in the US and Canada.[20] We connected key themes to standards set by the Liaison Committee on Medical Education (LCME), the accrediting body for medical education programs leading to the MD degree in the US and its territories.[21] We then invited participants to assist in the analysis of data and development of recommendations. Our primary aim was to provide an overview of design thinking educational programs in medical schools. Our secondary goals were to provide program operational details, describe curricular content and goals, and develop recommendations for integrating design thinking in undergraduate medical education that support LCME accreditation standards.

METHOD

We used a sequential explanatory mixed-methods design with an online questionnaire followed by semi-structured interviews to explore design thinking programs in medical schools.[20] The Institutional Review Board at the University of Illinois Chicago determined the study to be exempt from human subject research and therefore did not require ethics approval.

Recruitment

We employed purposive sampling to select educators involved in the training of undergraduate medical students in design thinking at accredited medical schools in the US or Canada. In this study, an undergraduate medical student was defined as a person enrolled in a regular schedule of courses in pursuit of a Doctor of Medicine (MD) or Doctor of Osteopathic Medicine (DO) degree. These degrees are analogous to the Bachelor of Medicine, Bachelor of Surgery (MBBS) undergraduate medical degree offered primarily in Commonwealth countries such as the UK, Australia, and India. To this end, we invited individuals via snowball (opportunistic) recruiting after the initial interviews.

Data Collection

We employed two sequential stages of data collection. We invited each participant to complete an online questionnaire in REDCap (Vanderbilt University, Nashville, TN) and then participate in a one-hour remote semi-structured interview via videoconference (Zoom Video Communications, Inc., San Jose, CA) administered by one researcher (AVP). The goal of the questionnaire was to elicit details regarding program

goals, curricular content, administration, and evaluation. The goal of the interview was to further explore, validate, and contextualise data provided by the questionnaire. Interviews were recorded and uploaded to Dovetail, a transcription and qualitative analysis software (Dovetail, Sydney, AUS).

Data Analysis

Descriptive statistics employed frequency (proportions), median, and range. Program location was classified according to the region (Midwest, Northeast, South, West) as defined by the US Census Bureau. We shared program overviews with participants, and they also edited overviews of their specific programs. We analysed the interview data via thematic analysis.[20] Two trained members of the research team (AVP and RMS) independently coded all the interviews. Constant comparative method was performed to coalescence codes into categories.[22] Finally, we invited participants to review the codebook and provide feedback on specific codes. One researcher (AVP) subsequently re-checked all interviews and associated codes to reflect the finalised codebook. Researchers AVP and RMS then drew out key themes from the finalised codes and categories via thematic analysis.

The research team connected themes to curricular expectations for medical schools. To maintain a single cohesive framework, we selected the standards set by the LCME. To achieve and maintain accreditation by LCME, a medical education program leading to the MD degree must demonstrate appropriate performance on 12 standards that flow from the level of the institution (Standard 1: Mission, Planning, Organization, and Integrity) to the level of the student (Standard 12: Medical Student Health Services, Personal Counseling, and Financial Aid Services). We mapped results of our study to the LCME Standards for the Function and Structure of Medical Schools, as published in March 2023 for the 2024–2025 Academic Year.[21]

RESULTS

We halted the recruitment process once snowball sampling revealed no new potential study participants to invite. Eleven of fifteen (73 per cent) of individuals invited responded to the recruitment email. Four individuals who agreed to participate were not eligible because they did not teach medical students. We included seven educators in the study: four had a medical degree (MD) and three had a doctoral (PhD) degree in design systems, bioengineering, or learning sciences (Table 1). All seven participants completed the questionnaire, and six participants completed the interviews conducted in March 2023.

Overview of design programs

The seven medical schools that included design programs are located across all four US Census Bureau regions. The design programs had been operating for a median of seven years (range: 2–8 years). Four programs spanned all four years of medical school, and three had a length of one year or less. Estimated contact hours ranged from 10 to 180 hours (median 30 hours). Four of the seven programs were co-led by a physician and an individual with training in one other discipline, most often a PhD in biomedical engineering. Only one program did not have a physician as part of its faculty. One of the seven programs was co-led by an individual with a PhD in design. The physicians had varying levels of training in design, ranging from experience working with designers to completion of certificate programs offered by a design consultancy; none held a professional degree (master’s or doctorate) in design.

Table 1: Overview of design thinking programs (programs listed in alphabetical order of institutions)

Institution	Program Name	Program Duration	Region – Division (Location)	Estimated Contact Hours and Program Length	Faculty Training
1. Medical College of Wisconsin	Transformational Ideas Initiative	5 years (founded Spring 2018)	Midwest–East North Central (Milwaukee, WI)	12 hours across 1 year*	PhD in learning sciences, master's degree in educational psychology
2. Rush University Medical College	Innovation in Medicine	2 years (founded 2021)	Midwest–East North Central (Chicago, IL)	30 hours across 1 year	PhD in design and MD
3. Thomas Jefferson University, Sidney Kimmel Medical College	Scholarly Inquiry in Design Thinking Track	7 years (founded 2016)	Northeast–Middle Atlantic (Philadelphia, PA)	40 hours + option for summer program across 4 years	MDs with design training and industry designers
4. University of California San Francisco School of Medicine	Discrete lectures + elective course	7 years (founded 2016)	West–Pacific (San Francisco, CA)	6.5 hours of lectures across medical curricula + project-based elective course	MD with design training
5. College of Medicine, University of Illinois Chicago	Innovation Medicine Program	8 years (founded 2015)	Midwest–East North Central (Chicago, IL)	180 hours across 4 years	PhD in engineering and MDs with previous intellectual property development
6. University of Virginia School of Medicine	UVA Medical Design Program	8 years (founded 2015)	South–South Atlantic (Charlottesville, VA)	10 hours across 1 semester	MD with design training
7. Vanderbilt University School of Medicine	Medical Innovators Development Program	7 years (founded 2016)	South–East South Central (Nashville, TN)	172 hours + industry internship across 4 years	PhDs in engineering and MDs

*Transformational Ideas Initiative is activity changing to a format with an optional 2nd year of content.

Overarching themes and relationship with LCME standards

The emergent themes and subthemes, explanations, and illustrative quotations are available and are mapped to the relevant elements of the LCME standards (Table 2). Each of the 12 accreditation standards comprises an accompanying set of 6 to 12 elements that provide specific expectations that guide compliance. Three of the four identified themes—(1) teaching students to investigate problem spaces before generating solutions, (2) developing collaborative practices, and (3) balancing students' interests in design with demands of medical school and a clinical career—are relevant to elements of LCME Standards 6

(Competencies, Curricular Objectives, and Curricular Design) and 7 (Curricular Content). Elements 7.4 (Critical Judgement/Problem Solving Skills), 7.6 (Structural Competence, Cultural Competence, and Health Inequities), 7.8 (Communication Skills), and 7.9 (Interprofessional Collaborative Skills) seem particularly well addressed by the goals and content of design thinking education. The co-curricular nature of these programs speaks directly to the requirement that schools offer substantial elective opportunities (Element 6.5), and most incorporate learning environments that include students enrolled in other health professions (Element 6.7). The fourth theme, which captures design thinking educators' focus on customising program details to meet the unique context of each institution and engaging in regular program evaluation and iteration, exemplifies the curricular management principles embodied in Elements 8.3 (Curricular Design, Review, Revision/Content Monitoring) and 8.4 (Evaluation of Educational Program Outcomes).

Table 2: Results of thematic analysis of semi-structured interviews with design thinking educators

Themes and Subthemes	Exemplar Quotations	Relevant Elements of LCME Standards
Balancing design and medicine		
Student interests outside of medicine	"Our students want to have impact not just at the bedside; they want to have impact at a population level."	6.5: Elective Opportunities
Demands of medical school	"A group has just hit a wall because they're in their third year of medical school and their time is just gone. They just physically don't have enough time to commit."	
Demands of a clinical career	"I've heard from students I keep in touch with that they're totally consumed with residency, so they say, 'I have the aim of coming back to this, but I'm not in a place to do that yet.'"	
Investigation before ideation		
Understanding stakeholders	"Sometimes they start to do stakeholder investigations and interview people and realise that what they thought they needed to do isn't actually what stakeholder groups wanted or needed."	7.6: Structural Competence, Cultural Competence, and Health Inequities
Defining the problem	"If you can adequately define a design challenge, solution design is the easy part. We work a lot in, 'Let's really understand the features that people want and the constraints on the system' so we can whittle down to 'This is the very well-defined design challenge.'"	7.4: Critical Judgment/Problem-Solving Skills
Developing collaborative practices		
Learning a shared language	"If you learn a shared lexicon, you can subscribe to something that's fairly codified like design thinking as opposed to making up your own words."	6.7: Academic Environments 7.8: Communication Skills
Learning different disciplinary approaches	"We want them to have a good foundation in understanding different perspectives, like how an engineer thinks about needs analysis and unmet	

	clinical opportunities, or a business student, or a design student."	
Working with different disciplines	"Our program began through the idea of creating a collaboration across different industries and across different parts of the University."	7.9: Interprofessional Collaborative Practices
Unique programs for unique situations		
Regular program iteration	"If your own innovation program cannot innovate rapidly from within, then you failed."	8.3: Curricular Design, Review, Revision/Monitoring
Customizing evaluations with leaderships	"First and foremost, know your audience. There's an entrepreneurship quality to this because there's no one-size-fits-all to convincing someone to support you."	8.4: Evaluation of Educational Program Outcomes

Student outputs

In addition to the development of services (six programs), information tools (six programs), and products (four programs), student outputs included curriculum initiatives (Medical College of Wisconsin's Transformational Ideas Initiative) and design briefs for industry clients (University of Virginia's Medical Design Program). Two programs featured opportunities for industry-facing internships (Vanderbilt's MIDP and Thomas Jefferson's SI Design). All programs described problem-solving as a goal of teaching design thinking to medical students. All programs taught techniques in the initial phase of problem-solving, including problem identification, information gathering, information organization, and idea generation. However, fewer programs taught implementation (four programs) and evaluation (two programs).

All programs emphasised the importance of teaching students the core skill of problem definition. Educators mentioned medical students' propensity to generate solutions to problems *a priori*, thereby prompting programs to help students move from "ideating without context" to "ideating with context." For example, students interested in developing interdisciplinary clinics would be encouraged to interview clinic managers to scope barriers and facilitators before presenting a proposal. When one educator sought to emphasise the importance of problem definition, they said, "If students are already in the solution space, I can't help them in the design space, because they hold on really tightly to what they've already solved, despite the fact that it's based on assumptions and not from engaging with the people around them." Students were accordingly encouraged to interview stakeholders and relevant end users such as patients, service users, and family members. Programs taught methods for gathering stakeholder information and implemented frameworks to have students comprehensively define and redefine problems before progressing to the solution-generating phase of the curriculum.

All programs also sought to develop students' propensity for collaborative practices. Developing ways of working with others involved teaching students to learn to use a shared language with other disciplines, to understand different disciplinary approaches to problem-solving (eg, quality improvement or business mindsets), and to be comfortable working directly with content experts in different fields. One educator stated that their goal was to teach an "approach in which you're merging design thinking with

implementation science and the business management angle so that if you have an idea and you want to make a business out of it, you should be able to do that as a physician." This focus on interdisciplinary collaboration was also reflected in the lived experiences of many educators themselves, as they described having different industry experts serve on their programs' primary education teams or as partners and guest lecturers.

Curriculum management and evaluation

The design of the programs' curricula required balancing high student interest with growing competing responsibilities of medical school. When describing the process for soliciting applications, one educator stated, "I put out the link to the Google form, and then go home and [think], 'This is the year nobody's going to show up.' [A] few days later I'm panicking because there's so many applications, and I'm desperate for the form to close." Educators mentioned the value of leveraging the summer between students' first and second years of medical school so as not to compete with the demands of classwork. Educators reported thinking broadly about the applicability of curricular content to students' future careers as physicians. For example, educators argued that design thinking's systematic approach to problem-solving would develop relevant skills in areas such as product development (eg, new healthcare device or software application), quality improvement (eg, reducing hospital readmissions), and the development of contextually relevant differential diagnoses and management plans (eg, discussing medications with no out-of-pocket costs as part of a shared decision-making conversation).

There was substantial heterogeneity in how the research team evaluated design programs. The most common forms of program evaluation were measures of student satisfaction through questionnaires or interviews (all seven programs). Educators reported developing customised evaluations in concert with leadership, such as a qualitative annual report, to supplement more traditional forms of evaluation. When describing his relationship with the Dean overseeing the design program, one educator stated, "I went to him and said, 'What do you need from me? What value can I bring to you?' And he said, 'You define that.'" Other evaluation techniques included student residency match results, number of invention disclosures or patent applications submitted, enrolment growth, industry partner growth, and class diversity. Only four programs included an evaluation of student projects.

DISCUSSION

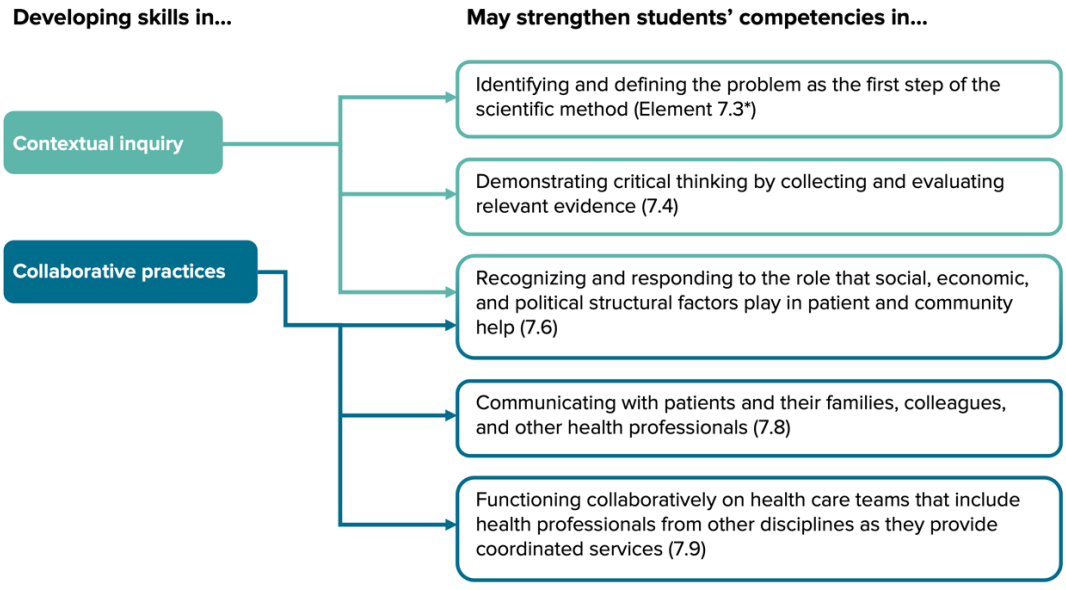
In this report, we provided an overview of programs teaching design thinking to undergraduate medical students in US medical schools. We identified seven programs located across all four regions of the US, each with a unique approach to teaching design, resulting in variations in program length, trainer credentials, techniques taught, student outputs, and methods of evaluation. Despite this heterogeneity, all programs emphasised developing skills in stakeholder engagement, problem definition, and interdisciplinary collaboration. Fewer programs taught strategies for implementation and evaluation. All programs used forms of evaluation based on student satisfaction.

Some educators have proposed a role for design thinking pedagogy in undergraduate medical education, citing design's potential uses in developing new products and ways of thinking; considering novel approaches to healthcare delivery; and improving patient and clinician satisfaction.[9,14] A qualitative literature review in 2019 on the use of design thinking in research on health professions education identified four US–based studies.[13] Another report identified 28 innovation and entrepreneurship programs in medical

schools and noted variability in core competencies, challenges in measuring outcomes, and an emphasis on interdisciplinary and interprofessional education.[5] Our study adds to this growing body of literature by providing insights elicited directly from program faculty and mapping the goals of design thinking programs to discrete elements for medical school accreditation.

The skills emphasised in design thinking programs are consistent with and can reinforce students' ability to achieve several aspects of expectations for medical school curricula, most notably those related to curricular structure and content (eg, LCME Standards 6 and 7), and including key areas in need of more emphasis in curricula such as problem-solving skills and interprofessional educational opportunities (Figure 1). By emphasising investigation before ideation and developing collaborative practices, design education may prepare medical students to meaningfully effect change in health care on both the interpersonal and systems level. By avoiding premature closure in decision-making and differential diagnosis, and by not only identifying stakeholders across the healthcare system, but also understanding how they relate to one another and engaging them, students may learn to work with experts from other fields to develop novel products and services and implement policy changes. Collaborative practices, including involving interdisciplinary colleagues and end users of systems, is a key focus of design thinking.[23]

Figure 1: **Relevance of design thinking programs' emphasis on developing skills in contextual inquiry (investigation before ideation) and collaborative practices to various content areas listed in LCME elements**



Despite contributions to key curricular elements and high levels of student interest in design thinking programs, empirical data are lacking regarding the effectiveness of the methods currently used to teach these concepts. This is not a unique problem; a scoping review of clinical reasoning assessment methods identified that many tools in common use were poor to average at assessing student competencies in information gathering, hypothesis generation, and problem representation.[24] Such gaps are not ideal,

however. Educators with expertise in design, medicine, engineering, and education may consider working together on the shared goal of devising better competency-based evaluation methods for problem definition and collaborative practices.

The development of modes of competency-based evaluation will allow future researchers to reconcile the heterogeneities noted in design thinking program details. For example, many educators leading design thinking programs in undergraduate medical education did not possess advanced degrees in design. By leveraging competency-based evaluation of programs, the value of discrete details of a program structure, such as required credentials of educations, can be elucidated.

Strengths of this study include its sequential explanatory mixed-methods design, which combined both questionnaires and semi-structured interviews to collect program data. Combining quantitative with qualitative data allows for a multidimensional examination of data, providing necessary and valuable context that could not be captured via a single cross-sectional survey. We reviewed all data presented in this report with study participants, who also assisted in the development of the study manuscript. The diversity of our study team, including a multinational group of educators across three countries with expertise in medicine (including a medical student AVP), engineering, design, and education, aided in the development of a comprehensive review of the programs.

This study also has some limitations. While this report was based on a review of a modest number of programs in North America, our snowball sampling approach reached saturation with identifying 15 programs, of which 11 agreed to participate in the study and 7 met the study inclusion criteria. Whether our findings can be generalised to medical schools elsewhere needs further study. The current report relied on information from design program directors and information available on program websites; interviews of overseeing Deans and medical students enrolled in design programs could help identify additional stakeholder insights.

All seven programs are located within the US, and key program themes were connected to standards set by the LCME, the main accreditation body in the US. Nevertheless, the key curricular themes of contextual inquiry and collaborative practices to navigate innovation in a complex health system are broadly applicable to medical students beyond the US. The design of services is especially pertinent to practitioners located within nationalised health systems and countries with universal insurance, as service benefits can be extended across the system. It would be interesting to use results of the current study to design future studies that include a systematic query of all accredited medical schools in the US or other countries.

CONCLUSION

Design thinking programs at LCME-accredited medical schools across the US have substantial heterogeneity in program leadership and administration, learning environments, faculty preparation and participation, education resources and infrastructure, curricular content, and program evaluation. However, all programs emphasised problem definition and collaboration, which aligned with several key competencies required by LCME accreditation standards, such as critical judgment and problem-solving skills and interprofessional collaborative practices. Future work may include the development of interprofessional consortia of medical and design educators to cocreate tools to assess student competencies in design and an assessment of whether design education programs help medical schools better meet LCME

accreditation standards.

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- AVP and RMS contributed equally in the conception and execution of the study;
- JAK and HM contributed equally as senior authors overseeing the study;
- SB, PB, RB, RHC, KE, MH, PHJ, MK, AL, LMM, AS, and MT all contributed to data analysis and draft proofreading.

PEER REVIEW

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CONFLICTS OF INTEREST

The authors declare that they have no competing interests.

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ETHICS COMMITTEE APPROVAL

The Institutional Review Board at the University of Illinois Chicago (FWA #00000083, Protocol STUDY2023-0090) determined this study met the criteria for exemption from ethics committee approval.