Comparing the Effects of Design Thinking and A3 Problem-Solving on Resident Attitudes Toward Systems Change

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ABSTRACT

Background Quality improvement (QI) is a required component of graduate medical education. Many medical educators struggle to foster an improvement mindset within residents.

Objective We conducted a mixed-methods study to compare a Design Thinking (DT) approach to QI education with a Lean, A3 problem-solving approach. We hypothesized that a DT approach would better promote a mentality of continuous improvement, measured by residents' resistance to change.

Methods Thirty-eight postgraduate year 2 internal medicine residents were divided into 4 cohorts during the 2017–2018 academic year. One cohort participated in an experimental QI curriculum utilizing DT while 3 control cohorts participated in the existing curriculum based on Lean principles. Participants voluntarily completed a quantitative Resistance to Change (RTC) scale pre- and post-curriculum. To inform our understanding of these results, we also conducted semistructured interviews for qualitative thematic analysis.

Results The effect size on the overall RTC score (response rate 92%) was trivial in both groups. Three major themes emerged from the qualitative data: factors influencing the QI learning experience, factors influencing creativity, and general attitudes toward QI. Each contained several subthemes with minimal qualitative differences between groups.

Conclusions This study found similar results in terms of their effect on attitudes toward systems change, ability to promote creative change agency, and educational experience. Despite positive educational experiences, many residents still did not view systems-based problem-solving as part of their professional identity.

Introduction

Quality improvement (QI) is a required component of graduate medical education (GME).[1] In 2017, the Accreditation Council for Graduate Medical Education (ACGME) formalized the expectations for QI education in the Common Program Requirements, prompting even more curricula in this area.[2]

Teaching QI in GME often involves guiding residents through a project designed around a local gap in health care quality, using A3 problem-solving.[3,4] These curricula are based on principles from Lean[5–7] and the Model for Improvement[8,9] which use the plan-do-check-act (ie, Deming) cycle.[10] However, many medical educators still struggle with how to adapt them to health care and meaningfully engage residents in ways that promote a mentality of continuous improvement.[11–13]

Innovation frameworks such as Design Thinking (DT) are now being taught in some medical schools.[14] Several major health care systems have leveraged these frameworks to improve patient outcomes while remaining economically viable in the volatile health care market.[15,16] DT emphasizes observation, empathic interviewing, and immersing oneself in a problem from another person's perspective. The insights gained inspire inexpensive, low-effort prototypes that can be rapidly tested through small-scale iterative experiments to methodically test evolving hypotheses (TABLE 1).[17,18]

We hypothesized that a DT approach to QI would more strongly promote a mindset of continuous improvement in residents, compared with traditional QI curricular approaches because of the similarities between DT and clinical medicine, namely their explicit focus on empathic problem-solving. Since all QI work requires change, we drew from Rogers' Diffusion of Innovations Theory, which posits that an individual's willingness to adopt change falls on a

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bell-shaped curve.[19] We then hypothesized that learning a structured approach to problem-solving in a familiar health care context with conceptually accessible QI tools could positively affect one's own attitude toward systems change, regardless of where one might naturally fall along Rogers' curve. We utilized a quantitative measure of residents' attitudes toward change as a curriculum evaluation measure for our research, then performed qualitative interviews to inform our understanding of this measure and which elements of the curriculum had the most influence on resident attitudes.

Objectives
We conducted a mixed-methods study comparing Design Thinking and Lean A3 Problem Solving as frameworks for an experiential quality improvement (QI) curriculum for postgraduate year 2 internal medicine residents.

Findings
Design Thinking and Lean A3 Problem Solving methods yield similar qualitative and quantitative results in their ability to foster a mindset of continuous improvement among internal medicine residents.

Limitations
This study was conducted at a single center, with one cohort of categorical internal medicine residents.

Bottom Line
Design Thinking could expand the toolset of a QI educator, but many residents do not view systems problem solving as part of their future professional identity.

Methods

Setting and Participants

The QI curriculum for categorical internal medicine residents at our institution is delivered during the postgraduate year (PGY)-2 in the form of an experiential longitudinal project, facilitated by a faculty member with QI training and experience. The curriculum includes 16 in-person contact hours distributed over 10 months in the form of 1- or 3-hour teaching sessions every 8 weeks. During our study period, there were 38 categorical residents in the PGY-2 class. Residents are randomly grouped into 4 cohorts of 8 to 12 residents. Each cohort works on a different project that is facilitated by 1 of 4 faculty members. These faculty members, referred to as core QI faculty in our residency program, are proficient in A3 problem-solving and had at least 3 consecutive years of experience teaching QI to residents prior to the study. During this study, one core QI faculty member (R.B.) had both Lean A3 training and DT training. This study took place during the 2017–2018 academic year.

While our institution utilizes a blended QI framework that incorporates elements from both the Model for Improvement and Lean, the internal medicine residency program utilizes the Lean A3 problem-solving approach as the scaffolding for its curriculum.

Intervention

During the study period, we had one experimental group of residents (cohort D) who learned and applied the DT framework to approach a local QI problem. The other 3 groups of residents (cohorts A–C) served as control groups and learned to apply the A3 problem-solving framework to a local QI problem. The curriculum for the experimental DT cohort (provided as online supplementary data) was

TABLE 1
Curricular Concepts and Activities for A3 Problem-Solving (Control) and Design Thinking (Experimental) Quality Improvement Curricula

A3 Problem-Solving Curriculum	Design Thinking Curriculum
Core Curricular Concept Project Activities	**Core Curricular Concept Project Activities**
Find Defining the purpose and scope the project, identifying key stakeholders, developing a team charter	Empathy Identifying a broad spectrum of end users, interviewing, observation, immersion
Organize and Clarify Observing and outlining the current state of the problem, identifying value and waste, defining metrics	Define Applying varying lenses and perspectives to the problem, analyzing interview data for themes, forming "How might we…" questions
Understand Analyzing and prioritizing potential root causes	Ideate Brainstorming using "How might we…" seed questions
Plan-Do Defining the target state, proposing and prioritizing countermeasures (possible interventions)	Prototype Bringing ideas to life with rough, incomplete, but testable versions of a product or process
Study-Act Measuring changes, sustaining positive gains, replicating and disseminating	Test Bringing your prototype to users for small scale experimentation and feedback

TABLE 2
Characteristics of Quality Improvement Projects in a Study of Design Thinking vs A3 Problem-Solving in an Internal Medicine Residency Program

Characteristics	Cohort A (Control)	Cohort B (Control)	Cohort C (Control)	Cohort D (Experimental)
Curricular framework	A3 problem-solving	A3 problem-solving	A3 problem-solving	Design thinking
Quality improvement project topic	Decreased ventilator days through the implementation of an evening rounding checklist	Improving communication during the inter-hospital transfer process	Improving the safety of the hospital discharge transition through a discharge checklist	Reducing interruptions during handoff
Clinical microsystem	Medical intensive care unit	General medical ward	General medical ward	General medical ward
Leadership vs resident selected	Resident	Resident	Leadership	Leadership

developed using tools and resources available online to the public through IDEO and The Hasso Plattner Institute of Design at Stanford[17,18] as well as educational resources recommended by the chief innovation officer at our institution.[20–22] The curriculum for the 3 control cohorts was developed and refined by our faculty over many years and is grounded in the A3 problem-solving approach to QI.[3] An outline of this curriculum can be found in the online supplementary data. The characteristics of each cohort's QI project can be found in TABLE 2. QI projects were selected based on resident interest (cohorts A and B) or departmental and residency program strategic priorities for QI that involved residents (cohorts C and D). During the study period, residency program leadership requested that one cohort work on the problem of handoff interruptions. The QI faculty member for cohort D (R.B.) addressed this problem with his cohort.

Outcomes

We used the Resistance to Change (RTC) scale (provided as online supplementary data) as a quantitative measure of residents' attitudes toward systems change before and after the curriculum.[23] Semistructured interviews were analyzed using thematic analysis[24] as the qualitative evaluation to inform our understanding of resident attitudes toward health care systems change, how the curriculum may have impacted their views of change, other aspects of the curriculum, and QI as a discipline.

Quantitative Outcomes

The RTC scale is a 17-item, 6-point survey instrument that has validity evidence through studies in adult populations and was "designed to measure an individual's dispositional inclination to resist changes."[23] It was administered on paper before and after participation in the QI curriculum. Each response form was deidentified, but pre-post linkage was maintained using unique identifier codes.

RTC scale responses were tabulated and analyzed for effect size using Cohen's d.[25] Effect size was chosen as the statistical measure for this study because of the small size of our experimental group. Using Cohen's standards, an effect size with an absolute value < 0.2 was considered trivial, ≥ 0.2 to < 0.5 was considered small, ≥ 0.5 to < 0.8 was considered medium, and ≥ 0.8 was considered a large effect. A negative effect size indicated a decreased resistance to change and was considered the desirable outcome.

Qualitative Outcomes

An interview guide (provided as online supplementary data) was developed through an iterative process by the research team, comprised of 2 medical educators with QI expertise (R.B. and J.M.), a qualitative researcher (J.S.), an MD/MPH candidate (A.S.), and the chief innovation officer of our institution (R.R.). All residents were invited to participate in a semi-structured interview via email. No additional incentives were provided. Interviews were conducted in person or over the phone from May to July 2018 by a trained interviewer (A.S.) who had no association with the development of the QI curriculum or the leadership of the internal medicine residency program. All interviews were audio-recorded, transcribed, deidentified, and loaded into NVivo 12 (QSR International Inc, Burlington, MA) for analysis. Interview transcriptions were reviewed for accuracy against the audio recordings.

The research team developed a codebook for analysis through an iterative process. Interviews were analyzed by 2 investigators (R.B. and A.S.) who met routinely to review and refine coding. Four interviews were selected for duplicate coding with interrater

reliability reaching an initial median kappa of 0.57 (-0.01–0.95). Coding differences were discussed until agreement was reached, changes were made to the codebook, and a second round of duplicate coding with 4 more interviews was conducted. After this round, the combined interrater reliability reached a median kappa of 0.66 (0.22–0.89) for all 8 interviews. Again, differences were discussed until agreement was reached with a focus on those codes with lower kappa scores. The codebook was adjusted, and remaining transcriptions were divided and coded by 1 of the 2 investigators. Once coding was complete, the research team used thematic analysis to identify emergent themes from the data.[26–28]

The study was reviewed and considered exempt by the University of Pennsylvania Institutional Review Board. While resident participation in the QI curriculum was a mandatory residency component, completion of surveys and interviews was voluntary, and verbal informed consent was obtained.

Results

The experimental group included 11 residents (11 of 38, 29%), while the other 27 residents (27 of 38, 71%) were divided among 3 control groups. Twenty residents (20 of 38, 53%) volunteered to participate in interviews, and we reached saturation of themes with these interviews. Eight of these residents (40%) were from the experimental group and 12 of 20 (60%) were from the control groups. All 38 residents completed the pre-curriculum RTC questionnaire, while 35 of 38 (92%) completed the post-curriculum questionnaire. The post-curriculum response rates in the experimental and control groups were 11 of 11 (100%) and 24 of 27 (89%), respectively.

Quantitative Results

At baseline, the average overall RTC score for the entire study population was 2.97. During validation studies, Oreg found means ranging 3.00–3.36.[23] At baseline, the average overall RTC score was higher, indicating more resistance to change, in the experimental group (3.26 of 6) compared to the control group (2.84 of 6). Postintervention, the effect size on the overall RTC score within each group was trivial, measuring 0.03 and 0.16 for the experimental and control groups, respectively.

Qualitative Results

Three major themes emerged from the qualitative data: factors influencing the QI learning experience, factors influencing creativity, and general attitudes toward QI. Within each major theme, there were several subthemes. Table 3 contains a full list of these subthemes with sample quotations. We will focus on the most prominent themes and note any differences between the groups.

Factors Influencing the QI Learning Experience

The 2 most prominent factors influencing the QI learning experience were peer engagement and learning a systematic methodology. Residents from both groups cited examples of how their peers' level of interest or excitement about the project directly impacted their overall experience. These comments carried both positive and negative connotations in both groups. Both groups viewed learning a systematic approach, either DT or A3 problem-solving, as a positive contributor to their experience. Facilitator factors such as enthusiasm, organizational skills, and delegation were noted by several residents as was the importance of having a personal connection to the problem they were trying to solve. Residents reported that working on a project that was meaningful to them and/or addressed a problem that they encountered in their work led to a more positive experience. This sentiment was expressed by residents in the cohorts who self-selected their QI project and the cohorts who worked on leadership-selected projects with relevance to residents.

Factors Influencing Creativity

Creative agency, or the recognition that an individual or team was able to creatively affect their environment, was noted by residents in both groups. Residents described that the curriculum helped them feel empowered to impact the health care system in a creative way. Most residents, regardless of group, believed in creative plasticity, or the thought that creativity could be learned to some degree. However, the experimental group more frequently displayed creative confidence or a positive self-image about their own creative skillset. Furthermore, the experimental group more frequently identified specific curricular activities as promoting creativity, describing many creative tools within the methodology. Residents from both groups described seeing medicine as the antithesis of creativity, citing treatment algorithms and clinical pathways as evidence. While this was not a widespread sentiment, some felt strongly that these skills were unfamiliar and at times even unnecessary in clinical practice.

Attitudes Toward QI

General attitudes toward QI surfaced when questions related to prior QI experiences and future career plans

were explored. There were no qualitative differences between groups under this theme. There was a mix of positive and negative attitudes with many residents simultaneously offering both views. One resident reported that their QI curricular experience helped them discover a new career interest in QI. Many residents identified applications in their future career for lessons learned during the curriculum. Some who identified specific career interests in basic science research or medical education saw a potential translation of QI methodology, such as creative problem-solving skills, to their specific career goals. Others saw benefits of QI knowledge and soft skills that they developed through their QI project, such as communicating with stakeholders and empathic interviewing. Still, while many residents saw opportunities to apply these lessons learned, several specifically mentioned that QI work was not part of their career plans.

Discussion

This study suggests equipoise between DT and A3 problem-solving as frameworks for QI curricula in their effect on internal medicine residents' attitudes toward systems change. While there were minimal differences between groups, our qualitative findings can help inform QI curriculum development in several respects. The most surprising results were that residents did not necessarily view creative problem-solving as a useful skill for their careers as physicians, and that despite being able to see other applications of QI skills, many residents did not view QI as part of their clinical work or professional identity as a physician.

Regardless of the curricular framework utilized, residents found value in learning a logical, systematic approach to QI. Perhaps this can be attributed in part to similarities between these frameworks. While the terminology is different, they are both rooted in the scientific method. Furthermore, residents are familiar with applying a structured approach to history-taking, differential diagnosis generation, and other aspects of clinical medicine, so this was not surprising. Similarly, it was expected that the level of peer engagement directly affected the learning experience. Since interpersonal dynamics are a key factor to the success of any team, and all QI work involves a team, this should be a deliberate consideration in QI curriculum design.

Other key factors to consider when developing a QI curriculum, regardless of framework, include project selection and faculty development. Our residents wanted to feel a personal connection to the problem they were solving. This sentiment did not seem to be directly related to the residents' control over project selection. However, residents who can select their own project are likely to choose something meaningful to them. This presents a challenge to QI educators who are trying to balance resident engagement with the desire to engage them in interprofessional projects that are aligned with local clinical quality goals.[12,29] Indeed, finding a QI problem that is meaningful to the residents, measurable, actionable, and institutionally aligned is the elusive holy grail of QI education. Since residents remarked on several facilitator factors such as enthusiasm for the subject, investing in professional development for QI faculty is likely to pay dividends both for assistance with project selection and for residents' learning experiences.

While curricula can be modified to influence the QI learning experience for residents, it is much more challenging to foster a mindset of continuous improvement. Residents in both the DT and Lean groups of our study recognized that QI concepts and skills could be applied to aspects of their future careers, but also did not view QI as part of their future work. QI education remains unpopular with many residents and medical students[30,31]; thus, the applicability of QI principles to other aspects of a physicians' career may be a critical "hook" for QI educators. It remains concerning that many of the residents in this study did not view improving health care as part of their future work as physicians. Some also viewed clinical practice as algorithmic, precluding creativity. Solving problems for individual patients and solving problems for the local health care system appeared to be conceptually different to our residents.

For resident physicians, the feeling of being powerless to effect change can loom large. While it was encouraging that residents across both groups reported feeling empowered to have a creative impact on their environment, we did not find meaningful quantitative shifts in either groups' overall RTC score. However, the qualitative differences in factors influencing creativity suggest that DT may have more effective applications for specific learners or specific problems. It is important to note that these frameworks contain tools, not formulas, and we believe that other QI educators could benefit from the expanded curricular toolbox that DT provides.

This study is limited in that only internal medicine residents in one cohort at a single institution were included, which limits generalizability. Comparison across groups is confounded by faculty differences. While all our faculty were proficient in QI methods, teaching abilities and level of enthusiasm for the subject among the faculty may have varied, which in turn could impact the residents' satisfaction with their education. Similarly, the selection of QI projects

TABLE 3
Themes, Subthemes, and Illustrative Quotes from Internal Medicine Residents Who Participated in a Longitudinal Quality Improvement (QI) Project-Based Curriculum

Theme	Illustrative Quote
Factors Influencing the QI Learning Experience	
Facilitator factors	"For participants that are not particularly interested going into a project like this, it [was] really helpful to have an instructor who was [so] enthusiastic."
Peer engagement	"Whether it was more the perception of how burdensome it would be or the emotional energy that it takes to invest in yet another kind of thing outside of work... I think there was difficulty getting people to take more responsibility and engage in the project."
Personal connection to the problem	"I thought that it could be really exciting if it was a project that aligned with my own interests, that maybe me and the rest of the team came up with, but when I heard that it was a department-wide project that had already been selected, my expectations were lower."
Stakeholder engagement	"The fact that it was difficult to get nursing staff or management to participate and buy into my project was one of the more frustrating experiences."
Learning a systematic methodology	"[This project] showed me that... you can actually take a complex problem and solve it when you go about it in a systematic way."
Time and effort commitments to the project	"As you know residency is very busy and there's kind of limited free time... so the concern was certainly that additional responsibilities that weren't necessarily in my area of interest would be kind of onerous or burdensome."
Distribution of curriculum time	"It was so spaced out... we dive into our inpatient service, and we get so busy with that that I feel like when I got back to the QI... I started to get lost in, 'well, where were we at before, and why are we going in this direction now?'"
Distribution of project workload	"Some people ended up shouldering more of the burden than others, which isn't necessarily fair to them."
Factors Influencing Creativity	
Creative confidence	"I saw that when given the time and the space to think creatively about problems... [I was] better able to come up with creative solutions to problems."
Creative skepticism	"I think I'm probably innately less creative in terms of my thought processes than other people."
Creative agency	"And it's been a very rewarding experience to be able to kind of create something on your own and push the boundaries of a field from a different angle that's your own."
Creative plasticity	"I think [creativity is] predominantly learned. I think that a lot of it probably is learned before our professional development stage but in childhood. But I think it can be learned later on too... It's more thinking within the realms of things that you see every day but putting them together in kind of new combinations."
Creative determinism	"I don't feel like I can really learn how to be [more creative]."
Creative tools within methodology	"Just getting back down to the brainstorming, I think that that involved a lot of personal creativity and taking out a board and sticking things on the board, like different ideas and stuff like that, that was all engaging our creative thinking."
Fostering individual creativity	"I guess kind of some of those strategies we use in other domains in terms of kind of listening and summarizing other people's viewpoints and then kind of finding a way to discuss them without being inflammatory or without dismissing."

TABLE 3
Themes, Subthemes, and Illustrative Quotes from Internal Medicine Residents Who Participated in a Longitudinal QI Project-Based Curriculum (continued)

Theme	Illustrative Quote
Fostering team creativity	"We had the little breakout sessions and we got to work in interdisciplinary teams and I think being able to see other people's perspectives and come up with plans that would work well with different groups of people I thought that that was the times when I was able to kind of use my creativity skills the most."
Medicine as the antithesis of creativity	"We don't get the chance to practice [creative] skills frequently. . . [medicine is] more algorithm-based and more needs to. . . happen quicker than is generally possible if you're trying to think creatively about things around you."
Attitudes Toward QI	
Negative pre-curriculum impressions	"[Initially], I was admittedly a little put off by what I perceived to be QI."
Positive pre-curriculum impressions	"I was excited. I had always been interested in quality and safety, but never had much experience in it. And it was a neat introduction to work on something as a group, as sort of the first go around to get a taste of whether I might actually be interested in this field."
Negative post-curriculum impressions	"This ended up being exactly what I thought, which is, I'm sure why I'm doing this because this is not what I want do with my life."
Positive post-curriculum impressions	"It's been a very positive initiative. I think it has actually improved upon patient care and improved upon staff relationships."
Prior didactic learning	"There were some [lectures] that were generally kind of based on root cause analyses and thinking about issues as they come up in the hospitals. We certainly heard all about the Swiss cheese model and thought about root cause analyses, but beyond that not too much."
Prior experiential learning	"As a fourth-year medical student, I was part of a quality improvement project myself with 2 other fourth-year medical students. We did a project looking at implementing of ambulatory blood pressure monitoring."
No QI in future career	"[QI is] like being a kindergarten teacher. It's a necessary thing, but it's hard to do and good people do it, but it's not me."
Benefits of QI knowledge or soft skills in future career	"I think, no matter what you do, trying to kind of see things with multiple lenses and having good communication skills [is beneficial]."
Translation of QI methodology to other domains of future career	"I think the real skill was sort of just learning how to think about a problem. . . critically. So even for someone that's not going into QI but is going into say medical education or. . . translational or clinical or basic science research, that question is sort of how to think creatively about the question."
Future career in QI	"I would definitely like to take a leadership role going forward. . . at least participating in projects or leading a project. . . I would like QI to be part of my career."

(resident selected vs leadership selected) varied among cohorts, which could have impacted resident attitudes. However, our qualitative results emphasized that the relevance of the problem to residents' work, rather than whether they selected the problem, was the more important factor. As we modify available DT resources to meet our curricular needs, other applications might produce different resident perceptions. The RTC scale has some validity evidence but was not designed to measure creative tendencies and has not been used with physicians, thus it may not have effectively captured resident attitudes toward change. The study was not designed to examine other outcomes such as QI knowledge or skills, so we are unable to determine if our approaches influenced these outcomes. Participants did not

provide feedback on our qualitative analysis findings, and the interview guide was not piloted with residents prior to use.

Future research steps may include exploring factors that influence resident professional identity formation related to QI and interventions or curricula that promote openness and creativity related to systems-based problem-solving.

Conclusions

This study, the first to compare different problem-solving methodologies for use in QI education, revealed qualitative and quantitative equipoise between DT and Lean A3 frameworks with both curricula fostering creative agency yet producing trivial effect size on residents' RTC. While our residents identified creative positive changes that they were able to effect on the clinical environment, as well as the broad applications of the skills learned, many still did not see systems-based problem-solving as part of their future professional identity or practice.

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