CHAPTER THREE

UNLOCKING THE POTENTIAL OF THE BRAIN: APPLYING NEUROSCIENCE PRINCIPLES TO PROMOTE CREATIVITY AND INNOVATION IN HEALTHCARE

RITA COLA CARROLL

Abstract

Creativity and innovation are central to promoting clinical excellence and strong health outcomes, optimizing healing environments, and advancing global health initiatives. Healthcare institutions expect that healthcare professionals (HCPs) are prepared to manage the existing and evolving challenges with creative and collaborative approaches that spur innovation and fuel progress in healthcare. Targeted training in the neuroscience of creativity can help HCPs understand the brain's creative processes and mobilize those functions to promote innovative healthcare practices. Meaningful professional development can affect real change when there is a focus on the factors and conditions that support creative cognition and innovative thinking. This process begins with training faculty in higher education so they may design curricula with instructional strategies to foster students' confidence in their abilities to create and innovate. This knowledge ultimately prepares HCPs to guide and inspire colleagues while cultivating environments that promote and value creativity and innovation as essential tools in navigating the challenges and opportunities in today's healthcare space.

Keywords: creativity capacity, creative cognition, innovations in healthcare, neuroscience, healthcare professionals

Introduction

Creativity and innovation are central to promoting clinical excellence and strong health outcomes, optimizing healing environments, and advancing global health initiatives. Healthcare institutions expect that healthcare professionals (HCPs) are prepared to manage the existing and evolving challenges with creative and collaborative approaches that spark innovation and fuel progress. Standards in healthcare practices and higher education, such as those found in "The Essentials: Core Competencies in Nursing Education from the American Association of Colleges of Nursing", recommend facilitating professional development grounded in creative and innovative thinking, as these skills are integral to excellence in clinical practice and leadership (American Association of College Nursing, 2022).

Citation: **Carroll, R. C. (2024).** Unlocking the Potential of the Brain: Applying Neuroscience Principles to Promote Creativity and Innovation in Healthcare, in Reisman, F. (Ed.), *Creativity, Motivation, Neuroscience, AI and Their Future* (pp. 66-86) London: KIE Publications. Available online: https://kiecon.org/creativity-books/[or insert your institution repository url]

Best practices in other health professions also point to the value of the creative process in supporting people in reaching their health goals. For example, in his seminal work, David Frey shared that counseling is a creative process noting, "in the broadest sense, counseling is actually a creative enterprise with which client and counselor combine their resources to generate a new plan, develop a different outlook, formulate alternative behaviors, and begin a new life" and that clinicians cannot always rely on technical skills but must to turn to inventiveness and creativity (1975, p. 23). This sentiment is found in the practice standards for other disciplines, as well. These standards not only guide healthcare professionals to meet challenges in their day-to-day workplace activities, but they can also assist health systems in addressing access to equitable quality care, contain costs, and advance the field to improve health outcomes on individual and community levels.

This chapter will review the critical importance of creativity and innovation in healthcare through the literature as well as the perspectives of HCPs who were surveyed on this topic. We will consider the foundations of the cognitive processes involved in creativity and why it is important to embrace the neuroscience of creativity and innovation as a means to catalyze transformation in healthcare delivery. Throughout this chapter, we will investigate the research and also hear from students, faculty, and healthcare practitioners as they share their views on the value of creativity and innovation across the healthcare continuum. Finally, we will explore the potential for engaging in relevant training in the neuroscience of creativity and innovation in higher education to better prepare students for work in healthcare post-graduation. This approach serves as a pathway for HCPs to effectively address the evolving needs of our complex healthcare systems.

What are Creativity and Innovation?

Creativity "involves transforming creative concepts into tangible outcomes that improve efficiency, and effectiveness, or address unmet needs" (Jain, 2023, para. 1). Creativity is the fuel for innovation and comes from thinking outside of the box to generate new ideas that have a positive impact and spur transformation and growth. Creative thinking may be represented by the research-based 11 creative thinking factors tapped by the Reisman Diagnostic Creativity Assessment (RDCA); namely, originality, fluency, flexibility, elaboration, risk-taking, resistance to premature closure, tolerance of ambiguity, intrinsic and extrinsic motivation, divergent and convergent thinking (Reisman et al, 2016).

One veteran nurse and professor said it best, "Creativity is the thought and innovation is the action" (V. Wilson, personal communication, 2024, June 3). Innovation sparks change resulting in the introduction of something novel that adds value and contributes to the organization as a whole (O'Sullivan & Dooley, 2008). Innovation advances new and better ways of addressing problems or needs, taking organizations to the next level with a growth mindset to achieve desired outcomes. In healthcare, innovation can be defined as "invention + adoption + diffusion… offering a novel idea, product, service or care pathway that has clear benefits when compared to what is currently done" (Kelly & Young, 2017, p. 121)

The Neuroscience of Creativity and Innovation

We start with an understanding of creativity as a springboard to how we can train healthcare professionals in creativity and innovation. "Creativity is a new (and at the same time, ancient) superpower of the human mind" (Swart, 2019, para. 4). This ability to think creatively is a primary means of cultural progress, yet the neural structure and function of the creative brain remain largely unknown (Beaty et al., 2018, Beaty, et al., 2023). We used to think that creativity was housed exclusively in the right hemisphere of the brain (Gregoire, 2019). This perception went along with the notion that creativity could not be cultivated, and people are born creative or are not. Previously, assessment and theory were based on narrow definitions of creativity related primarily to divergent thinking and the arts (Dietrich & Zakka, 2023). Functional MRIs and current research, however, tell a different story as we now have evidence of the interaction of the brain regions involved in creative cognition (Beaty et al. 2018).

It appears that during the creative process, we draw on neural pathways from all over the brain, and use them in unexpected ways, accessing seemingly unrelated thoughts to foster new ideas (Swart, 2019). Harvard researcher, Roger Beaty states, "It's the synchrony between these systems that seems to be important for creativity. People who think more flexibly and come up with more creative ideas are better able to engage these networks that don't typically work together and bring these systems online" (Harvard, 2018, para. 7). While research into the neuroscience of creativity is still in its infancy, some trends on brain connectivity and idea generation are emerging in the science.

Creative thinking relies on an understanding of a problem often coupled with seemingly spontaneous generation of novel ideas and then goal-directed evaluations of their usefulness and appropriateness (Chan et al., 2023). These elements point to the non-linear interplay of varied cognitive functions to arrive at a solution. Imaging shows us that creative thinkers demonstrate strong connectivity between the regions of the brain in which mind wandering, focused thinking, and selected attention are rooted, indicating that a whole-brain network is mobilized by simultaneously engaging the default, salience, and executive systems (Beaty et al., 2018; Chan et al., 2023).

The default mode network encompasses multiple interconnected brain regions and is involved in the internal generation of new ideas (Menon, 2023). This system is activated when one is not performing an external task and can show up as daydreaming, mind wandering, and a restful but awake state (Beaty, 2018). This is where those "Aha" moments may occur, as a novel solution seems to come out of nowhere, through a subconscious process. The executive control network in the pre-frontal cortex of the brain serves as a command center (Beaty, 2023). This brain region is involved in higher-order thinking and engages the conscious brain to think and maintain focus on a relevant and prioritized task (Beaty, 2023). We may see this in evidence when first considering a problem, and then again when considering the value and viability of potential solutions for implementation. But what makes the creative process possible is the salience network that regulates switching back

and forth between the default mode network and the executive control network to engage in this process of creative cognition (Vartarian et al., 2020). The salience network is often deeply involved in higher-order cognition as it detects and allocates attention and neural resources to relevant stimuli (Chan et al., 2023).

Neuroplasticity is the brain's ability to change its structure and neural pathways based on learning, behavior and environment and it plays a role in strengthening creative capacity (Marzola et al., 2023). What fires together, wires together, so the more we engage in creative processes the better we get at them. Exercising your creative muscles strengthens your creativity and can break the habit of defaulting naturally to ingrained thought patterns (Sun et al., 2016).

Metacognition can also enhance this process. Metacognition is "a person's ability to regulate their thinking and learning and consists of the self-assessment skills: planning, monitoring, and evaluating" (Medina et al., 2017, p. 9). Metacognition is often described as "thinking about thinking", and when we are aware of our cognitive processes, we have a greater ability to understand, analyze and regulate them (NSW Department of Education, 2020). Metacognitive capacity bolsters our understanding of how we think and learn to more effectively and creatively address real-world problems (Brooks et al., 2019). Self-reflection and feedback can inform metacognition as individuals evaluate the way they learn and think, identify strengths and weaknesses, and make necessary adjustments. This iterative cycle of reflection and feedback fosters continuous improvement and promotes a deeper understanding of one's thought processes for enhanced problem-solving and decision-making abilities in the health professions (Medina et al., 2017).

What Helps Creativity to Flourish or Wither?

With an appreciation of the neuroscience, we can consider conditions that inhibit creativity or allow it to flourish. For example, conditions that can stimulate creativity start with the individual's perception of a psychologically safe space to explore their ideas, and allowing the mind to wander (Beatty, 2020; McNulty, 2024). On the other hand, chronic stress can disrupt creativity (Vartarian, 2020). Further, certain aspects of creativity may be enhanced with training and practice (Abdazi et al., n.d.). This evolving view of creativity, whole brain activation, and the conditions that can disengage or nurture creativity can serve as a foundation for helping students gain confidence in their creative cognition and ability to innovate.

Internally, factors such as a passion for problem-solving and open-mindedness to diversity in ideas and perspectives can serve as fertilizer for creative thinking (Álvarez-Huerta, et al., 2022). Further, characteristics such as curiosity, dedication, and the ability to apply newly discovered knowledge can enhance creativity (Chang & Shih, 2019). Curiosity brings an attitude of discovery and inquiry, while divergent thinking helps us to see a wide range of possibilities. Neuroplasticity is another internal at play as practice does affect our creativity, The more one engages in creative thoughts and actions, the better able we are to activate those regions of the brain to produce creative

ideas. Creative thinking for innovation is a skill that must be learned, practiced, and developed (McNulty, 2024).

Persistent stress inhibits creativity, so stress management is essential for optimal creative cognition. Stress management activities, such as mindfulness meditation and guided imagery can help to bring a calm, and quiet mental state to fuel brain processes (Henrikson et al., 2020). Mindfulness can also stimulate divergent thinking and challenge habitual patterns that often dominate our thought processes (Henriksen et al, 2020).

Externally, organizational cultures that are safe, inclusive, and accepting foster creativity and innovation (Brewster et al., 2022). An organizational orientation towards learning and growth highlights the value of continuous improvement. Furthermore, an interprofessional, collaborative environment welcomes diversity in ideas for transformational change. (Zhang et al., 2017).

One leader in nursing higher education illustrated the importance of internal and external factors in promoting creativity:

> Internally, factors such as a passion for problem-solving, curiosity, open-mindedness, and a willingness to challenge conventional thinking are crucial. Externally, collaboration with diverse teams and disciplines can inspire fresh perspectives and ideas. Access to resources such as research funding, cutting-edge technology, and networking opportunities also facilitates innovation. Furthermore, feedback mechanisms and recognition for innovative efforts incentivize health professionals to explore new approaches and solutions. (J. Murphy, personal communication, 2024, May 9)

Another nurse leader expanded on these ideas stating:

> Internally, intrinsic motivation and interdisciplinary skills encourage creative problem-solving, while continuous learning and adaptability spark new ideas and unconventional approaches. Externally, a collaborative culture and access to cutting-edge technology promote experimentation, while supportive policies and funding enable research and risk-taking. Patient engagement identifies unmet needs, guiding tailored solutions, and global networks facilitate the exchange of best practices and new ideas. (Anonymous, personal communication, 2024, May 9)

Creativity can be taught when there is a focus on creative problem solving and the corresponding cognitive processes to tackle the challenges of modern-day healthcare spaces (ten Haven et al., 2022). Targeted training in the neuroscience of creativity can help HCPs understand the brain's creative functions and mobilize those resources to promote innovations in care and best practices. Meaningful education affects real change when coupled with conditions that support creative cognition and innovative thinking, such as group collaboration, stress mitigation, and strategies to foster the creativity of others. Guidance and constructive feedback for creative endeavors encourages continued efforts. In sum, these environmental characteristics encourage HCPs to guide and inspire colleagues by cultivating a workplace climate that promotes and values creativity and innovation as essential tools in navigating the challenges and opportunities in today's healthcare space.

Creativity for Clinical Practice

The Importance of Creativity and Innovation in Healthcare

HCPs are tasked with problem solving and change management, as well as innovation in healthcare practices, interprofessional collaboration, and leadership (Brewster et al., 2022). Further, creativity and innovation are core competencies and are seen as integral to clinical practice and leadership. The World Health Organization's Innovation Group defines innovation in healthcare as a great idea "to develop and deliver new or improved health policies, systems, products and technologies, and services and delivery methods that improve people's health. Health innovation responds to unmet needs by employing new ways of thinking and working" (Backhouse & Ogunlayi, 2020, p. 2). This formal statement confirms that healthcare systems require continuous innovation to meet the evolving global health needs of patients and providers, (WHO, 2024). One HCP's perspective reflected these ideas stating, "Creativity and innovation are crucial to drive progress, enabling the development of new treatments, technologies, and approaches to improve patient outcomes and enhance the overall quality of care" (Anonymous, personal communication, 2024).

With the challenges in today's healthcare landscape, and the quest for more effective, integrative, and high-quality approaches to health and wellness, HCPs are called upon to find new ways to use evidence-based practices to deliver quality healthcare in partnership with those we serve. Healthcare environments, however, may appear closed and insular, giving the appearance of a lack of interest in new and innovative approaches. One nurse expressed her concern about how to break out of this pattern:

> Healthcare as much as it can be formula, should be explorative. So much of what we do is based on rote learnings and textbook theories. While that is useful, it lacks allowing the health care professional the space to explore: Will something else work better? It also denies the patient the right to say no or to be open to other possibilities. So, I guess I would ask: How do we transform the current model that only allows the upper-level managers the ability to actively use creativity? How do we teach nurses to lean into their creativity? How do we teach doctors or upper-level management to consider and honor the creative process in the nurses who are interacting with the patients? (T. Hulett, personal communication, 2024, May 8)

This is How We Have Always Done It

Often, we think that creativity must bring innovation that is new and different, but it may just be improving upon an existing practice or procedure. Tiffany Kelley, PhD, MBA, RN, DeLuca Foundation Visiting Professor for Innovation and New Knowledge at the UConn School of Nursing proposes that "One of the most dangerous statements we hear in healthcare is, 'That's the way we've always done it.' We evolve when we become personally invested in addressing what is not working for the betterment of all" (Spader, 2020,

para. 12). One Occupational Therapist described the issue of resistance to change in health care:

> Creativity and innovation doesn't have to be something 'new' or all about technology, but can also be about finding different and more effective ways of implementing already existing treatments or concepts and tools that patients may already be using. As new therapists enter the field, it will be up to them to carry a large part of this burden as many therapists who have been around for a while are old school and may be more reluctant to change how they do things and prefer to stick with tried and true (W. Uhing, personal communication, 2024).

Another HCP echoed this sentiment, stating, "Just because it has been done that way for 5 minutes or 50 years, does not mean it cannot be improved -- and no idea is too small (V. Roy, personal communication, June 6, 2024). Still, another HCP confirmed this issue and noted, " Rigid adherence to narrowly formulated methods of delivering healthcare close out methods that may deliver positive results to people increasingly dependent on expensive pharmaceuticals… Open-mindedness and acceptance of other treatments may hold the answers. (Anonymous, personal communication, 2024, May 13).

When leadership and HCPs are open to ideas that may improve the patient experience or the functioning of healthcare systems and services, creative solutions can flow. An organizational culture in which positive change is embraced often respects diverse perspectives, a growth mindset, and a bit of risk-taking to achieve their goals for organizational advancement (Wong, 2019). These are the ingredients for fostering creativity and innovation in an environment that welcomes and recognizes creative efforts and enables HCPs to explore possibilities.

The Fear That Innovations Are Unapproachable Feats

There is value in helping students in the health professions to develop self-confidence in their abilities to be creative in the workplace. Some research indicates that self-beliefs about creativity play a key role in the cognitive process (Alvarez-Huerta et al., 2022). People with greater confidence in their creative abilities may be more likely to engage in creative tasks and to persevere when challenges arise (Beghetto & Karwowski, 2017). This is especially important as some HCPs may feel that innovation is best left to the experts as they see themselves as less experienced and unable to affect real change (Sentilkumar & Cole, 2022; Arias et al, 2021). This attitude does not account for the value of each person's ability to problem solve and highlights the need to expose HCP students in higher education to training and experiences that will build their confidence in their creative solutions.

Gube and Lajoie (2020) suggest approaching teaching with a focus on integrating a body of knowledge with flexible, adaptive skills and attitudes that support creativity and innovation to help new graduates in the health professions feel "empowered, self-aware, independent, and creative problem solvers and change makers" (Gube and Lajoie, 2020, p. 11).) This emphasizes the importance of promoting creative self-confidence in higher education,

considering the close association with building desirable professional competencies (Alvarez-Heurta et al., 2021).

Creativity Can Support Optimal Outcomes for Each Person Served

HCPs have shared that creativity and innovation are constant and necessary in day-to-day clinical practice. As each patient or client is unique, so are their needs. HCPs must be creative to adapt. One nurse elaborated on this:

> Creativity aligns with individualized care. Although principles of medicine may apply across the board, how each person affects and is affected by a disease, a medicine, or a therapy is unique and individual. Creativity in medicine is necessary and it must be applied like a layer of salve over dry skin. When you are the individual (or you are caring for the individual) who doesn't fit the textbook version, it is the balm of creativity that brings hope and sheds light on a unique and individual solution. (J. Shaw-Metz, personal communication, 2024, May 9).

Another HCP echoed this response, stating:

> At an individual level, healthcare professionals leverage creativity and innovation to personalize treatments and interventions, leading to more effective outcomes and improved patient satisfaction. While some approaches may employ a one-size-fits-all model, this rarely suffices. We require creative strategies that consider the entirety of a person's well-being. (J. Murphy, personal communication, May 9, 2024)

These comments align with a survey conducted by the American Nurses Association's Innovation Group. Their 2023 survey showed that 87% of nurses said that 40% or more of their daily work required creativity, and 85% found themselves responsible for unique problem solving (American Nurses Association, 2023). One healthcare administrator stated, "Health professionals who have been in the field for a while will tell you that they find their creative selves in clinical practice all the time, when there are unique needs and limited resources, in emergencies, and when problems persist" (Anonymous, personal communication, 2024, May 9).

Case Example

Creativity and innovation are valued in healthcare. It is how we advance and improve our healthcare system but what can we do to foster creativity and innovation? Graduate students in the health professions were asked about their creative experiences, "What is the most creative thing you have done as a nurse, or have seen someone do?" A veteran nurse who is also a graduate nursing student responded by sharing her own experience in developing and implementing a creative solution. Her story allows us to view some of the elements that promoted creativity at her workplace as she created a new, cost-effective, and valued program for a mission trip to Honduras. Jennifer Shaw-Metz (2024) tells the story in her own words:

> In February 2023, a team of Main Line Health (MLH) doctors and nurses travelled to One World Surgery (OWS) Honduras, to provide free surgical services to the underserved. As a PACU RN, I was inspired by the kindness, skill, and excellent quality of care by Honduran staff. Donations of medicine, supplies, and volunteers fuel this tremendous work at OWS.
>
> Recognizing the need for conservative medication utilization, a role for aromatherapy was identified. Aromatherapy provides a low side-effect, cost-effective, utilization-friendly option for anxiety and nausea. For our January 2024 mission, Main Line Health graciously donated 200 Lavender and Peppermint reusable Aromatherapy inhalants… One-to-one education for OWS volunteers and translators was provided. Translators educated Honduran nursing staff in Spanish, who, in turn, provided direct Spanish instruction to patients.
>
> Lavender was used to combat pre-op anxiety. Peppermint proved particularly helpful in keeping nausea at bay. Several patients stated the peppermint helped them "wake up very well". Before discharge, Honduran nurses reinforced education and patients often expressed gratitude. Seeing the positive effects on anxiety and nausea, many of the staff requested their own…. It was a joy to facilitate direct education and provide aromatherapy for 62 post-op patients and 38 staff members/OWS volunteers. Of the 100 patients/staff, 97 had never heard of or used Aromatherapy before and the response was extremely positive.

In speaking with her further, this graduate student and veteran nurse shared her initial dismay that OWS was short on supplies. Upon her return home, this situation continued to be on her mind, and she came home thinking about what she could do to improve the situation. Some time after the trip, she suddenly realized that there could be a role for aromatherapy as a complement to conventional surgical care that might offer cost savings and conservation of medication. She stated that she had organized a donation of aromatherapy "sniffers" for the surgical patients and staff of OWS Honduras. The project was a rousing success.

When asked about what contributed to her developing a creative solution, she cited the opportunity (serving on the trip as a nurse and learning about the need), resources (she had access to aromatherapy through her integrative health department at work), conviction (that this intervention would help the team reach its goals for surgical care) and compassion (thinking of helping others in a financially restricted program).

In this case, the nurse's creative idea was just the first part of the process and occurred with her initial drive to solve the problem. Next, her sudden "Aha" moment recognized a cost-saving solution, followed by her evaluation of the viability of the solution. This reminds us of that neuronetwork dance to arrive at a unique solution due to the interplay of the executive, default mode, and salience network. Her persistence in seeing it to actual innovative practice made the real change happen, and this occurred in a safe workplace culture, with diverse perspectives and a willingness to consider innovations.

Education and Training in Creativity and Innovation for Healthcare Professionals

This nurse's story illustrated some examples of key elements that fostered creativity and innovation, but is there a way to enhance the creative process through education and environment? All HCPs surveyed for this chapter indicated the importance of training in creativity and innovation. This was supported by a 2023 Nursing Innovation Survey conducted by the American Nurses Association. When 4,688 nurses were asked, "What would help to foster creativity?", education and training around creativity and innovation was the number two answer directly behind recognizing individuals for their creative work (American Nurses Association, 2023).

There is somewhat limited evidence that creativity and innovation are being taught in higher education for the health professions. In 2013, a sweeping literature review assessed curricula in the health professions to better understand the role of innovation in the health sciences and how it was taught (Dearnley et al., 2013). This report was commissioned to address the demand from the healthcare sector to ensure that graduates in higher education were well prepared to meet the demands of the changing healthcare landscape. While the report acknowledged the importance of innovation in advancing healthcare, significant gaps were identified.

This report indicated that creativity was essential to innovation, and a by-product of organizational cultures that intentionally stimulated creativity. The researchers, however, found no evidence that institutions made deliberate attempts to do so. Perhaps most importantly, the review highlighted the importance of promoting innovation and creativity in health sciences programs in higher education and the potential positive effect on graduating students as they would be better prepared to creatively adapt to the challenges in providing healthcare (Dearnley et al. 2013).

If we fast forward to the present day and the more recent publication of the New Essentials by the American Association of College Nursing (AACN, 2022) and other standards for varied health professions, we find that creativity and innovation are still valued. Nationally, innovation and creativity are at the forefront of the core competencies in healthcare education. For example, some universities offer certificate, as well as undergraduate and graduate degree programs addressing innovation in healthcare. While these kinds of offerings seem to be expanding, it is still challenging to identify peer -reviewed literature, professional literature, and practices that address structured approaches to teaching creativity and the connection between neuroscience, creativity, and innovation. This presents opportunities for higher education programs to expand curricula to include training in the neuroscience of creativity and innovation.

A Model for Faculty Training on the Neuroscience of Creative and Innovation

HCPs report that must be creative in clinical practice but have had little relevant formal training or support to do so. Today, faculty and leadership in

higher education programs in the health professions are tasked with guiding students through formal development of creativity and innovation competencies. Ultimately, healthcare systems benefit from employing HCPs who are trained and oriented toward creativity and innovation to meet the challenges of today's healthcare.

So, how can we bring creativity and innovation to healthcare as a mission of the profession? How can higher education, professional continuing education, and clinical practice be infused with creativity and innovation competencies to advance the delivery and administration of services for optimal health outcomes? Alvarez-Huerta et al. (2021) suggest that targeted training in creativity can bolster students' creative self-beliefs and that higher education programs must foster these skills through greater engagement with the learning process and instructional activities.

A place to start is with the training of faculty so they may develop course content that promotes competencies in creativity and innovation based on the neuroscience, the evidence base, and experiential learning. This training can equip faculty with a comprehensive understanding of the neuroscience of creativity and innovation, enabling them to integrate relevant research -based practices into higher education for applications in clinical practice and beyond. The goal is to empower faculty with this knowledge so they may design innovative curricula and enhance instructional activities to guide and inspire students in the health professions. Doing so cultivates an educational environment that teaches, promotes, and values creativity and innovation as essential for addressing the challenges in today's healthcare landscape.

Program Elements for Faculty Training

A model for training was developed with an anticipated outcome that faculty will better understand how they can support students in flourishing creatively. This prepares students to better navigate the complex healthcare landscape and bring innovation to clinical practice and leadership in the health professions. This faculty training program is online and synchronous with four 60-minute sessions. At the beginning of each session, there is an activity to promote interest and engagement, followed by an overview of core concepts, small group activities, and a debrief session. Faculty are asked to complete an independent self-assessment of their creative processes between sessions. The final session requires faculty to create a brief student activity to support students in bolstering their creative capacity with a focus on innovation in healthcare. This final session is accompanied by peer feedback that is targeted, actionable, and constructive. In addition to learning about the neuroscience of creativity, faculty learn about the roles of knowledge, practice, and environment in building creative capacity, as well as the impact of feedback on promoting creativity for powerful lessons in course content.

The four modules focus on these topics:

- Module 1: What are creativity and innovation, and how do our brains create and innovate?
- Module 2: What are the internal and external factors that inhibit or nurture the brain's creativity processes, and how do we set the stage for optimal creativity?

- Module 3: What are some instructional strategies that boost creativity and innovation?
- Module 4: Group presentations of student activities with peer feedback.

The intended outcome of this four-session program is that faculty will feel confident in their understanding of the neuroscience of creativity and innovation, and will be prepared to produce content and use instructional design to support student development of these essential competencies. During this targeted training, faculty gain insights into the ways creativity and innovation can be infused into the curriculum with opportunities to address some of the challenges healthcare professionals face. This aligns with the findings from Alvarez-Huerta et. al. (2021) demonstrating that creative self-concept is positively associated with student engagement in higher education. They suggest that this occurs when students "have the opportunity to participate in collaborative learning, meaningful interactions with faculty, higher-order learning, reflective and integrative learning, and high-impact practices (p. 8).

Instructional Activities to Promote Engagement, Creativity, and Innovation Higher Education for the Health Professions

Faculty who are intentional about teaching the science behind the creative process can engage students in instructional activities that spark interest in problem solving in new ways. As one faculty member stated, "Pursuing practice problem solving with creativity sparks ownership, fuels energetic learning, and engages healthcare professionals in advancing technologies and updating best practices" (J. Shaw-Metz, personal communication, 2024). Novel topics, such as the use of AI, real-world problem solving, Design Thinking, and partnering with diverse disciplines can offer students varied ways to learn creative problem solving skills that have direct applications to clinical practice and leadership in healthcare. These kinds of activities can engage students in a way that helps to build creative self-confidence and capacity (Alvarez-Heurta et al., 2021)

Using Artificial Intelligence to Bolster Creativity in Higher Education

Artificial Intelligence (AI) is the simulation of human intelligence processes (e.g., learning and reasoning) by machines, particularly computer systems (Uunona & Goosen, 2023). AI is a term coined by Stanford Professor John McCarthy in 1955 and defined as "the science and engineering of making intelligent machines" (Manning, 2020, para. 2). Today, Manning defines Artificial Intelligence as "human-centered", seeking "to augment the abilities of, address the societal needs of, and draw inspiration from human beings. It researches and builds effective partners and tools for people" (2020, para. 9).

While AI is on the cusp of making real breakthroughs in supporting modern medical practices, it can also offer some opportunities for preparing healthcare professionals for their clinical and leadership responsibilities. Can AI really help health professionals be more creative and innovative in their

work and help to advance the delivery of health services? One faculty member at a university specializing in health sciences saw the potential for AI, stating:

> Change is consistent and as health providers, we must be able to use our creativity to innovate to meet the changing needs of people, healthcare systems, and societal standards. The introduction of Artificial Intelligence requires creativity so we can consider how this new tool will support useful innovation in the development and delivery of healthcare to the diversity of people who are living within a variety of contexts. (G. Gonzalez-Kruger, personal communication, 2024, June 10)

Institutions of higher education are expected to cultivate skills in creativity and innovation through curricular and instructional design. This mandate poses unique challenges to universities, but AI can offer some opportunities as a "collaborator". AI applications, such as ChatGPT and Claude can help students to brainstorm ideas and spark a creative process that identifies potential solutions from a wider lens than any one person can. This simple AI function can be a catalyst in the creative process.

Weiland et.al., (2022) widen the view of the value of AI and posit that AI could not only serve as a brainstorming partner with benefits of increased productivity and idea diversity, but it may also enhance this dynamic process for users as there is a reduced fear of negative peer evaluation. While AI may be an effective brainstorming partner, users are cautioned to carefully consider AI's generation of original content. Users must know their topics well and review content carefully for wording, accuracy, and potential bias. While AI-generated content may be a springboard to other ideas, it should not be considered an authoritative source of information.

Shark Tank-Inspired Activities

The cultivation of creativity and innovation in higher education is essential, particularly for the health professions. The reality TV show, Shark Tank, is a model for an instructional activity that can achieve this goal. In this show, contestants pitch their inventive solutions for everyday problems to a panel of seasoned business leaders, seeking investment and valuable feedback (Cofrancesco et al., 2017). This format, when adapted for academic settings, provides students with a platform to present and defend their creative projects, receive constructive criticism, and garner support to advance their ideas.

Faculty at the University of Massachusetts Chan Medical School have tested this format in a revised healthcare business course. By incorporating a Shark Tank-inspired project, students were provided with a rich educational experience while they gained confidence in their abilities to innovate and create (Gravlin et al., 2022). The course emphasized the importance of faculty support in guiding students to advance clinical and financial initiatives. Regular training sessions with healthcare innovators and industry leaders provide faculty with diverse perspectives on transformational change to provide cutting-edge guidance to students. In course evaluations, students

expressed the value of effectively articulating healthcare needs and designing viable solutions (Gravlin et al., 2022).

In a collaborative effort, faculty from the University of Virginia and Johns Hopkins University School of Medicine developed a two-week online course to promote creative, collaborative problem-solving, focusing on real-world healthcare issues and applying the fundamentals of high-value care. The final deliverable for this course was a presentation of creative solutions that were assessed in a Shark Tank-style format based on the originality of the problem addressed, the creativity and practicality of the proposed solution, and the clarity of the expected outcomes (Niranjan-Azadi, 2023).

The integration of Shark Tank-inspired instructional activities into higher education curricula for health professionals may be a novel approach that can foster an environment that enthusiastically welcomes creativity and innovation. It is here that creativity and innovation are valued and strengthened through constructive feedback, encouragement, and appreciation of diverse perspectives in problem solving as students build essential skills for today's healthcare landscape. By adopting such dynamic teaching methods, we prepare future healthcare leaders to think critically, act innovatively, and meet the complex challenges of modern healthcare with confidence and ingenuity.

Design Thinking in the Health Professions Curricula

Healthcare systems require continuous innovation to meet the complex needs of patients and the community, but often solutions do not take the human context into account, resulting in products and processes that fail. As revisions are made, time is lost and there can be long gaps between the identified need and the successful implementation of a solution (Altman et. al., 2018). Design Thinking flips the script by involving stakeholders throughout the process by incorporating stated needs and ongoing feedback to inform development.

The underpinning principle for Design Thinking is empathy to promote the discovery of the true cause of a problem, rather than relying on preconceived ideas (Spader, 2020). Design Thinking is an approach that prioritizes and values the user experience while working in collaborative multidisciplinary teams. The "action-oriented rapid prototyping" of solutions is a departure from the traditional linear, top-down approach (Altman et al., 2018, p. 1). As such, Design Thinking refers to a solutions-based approach to human-centered problem solving by focusing on understanding user needs and employing hands-on brainstorming and prototyping.

Some U.S. health education programs are now emphasizing Design Thinking in their curriculum to identify unmet clinical needs, develop prototypes, and create business models based on the input of stakeholders (Sandars & Goh, 2020). Daniel Pesut, PhD, RN, FAAN, professor of nursing at the University of Minnesota School of Nursing stated, "The end goal of Design Thinking is to make the user experience the best it can be. It's about creatively thinking forward, rapid prototyping, and testing ideas and products" (Spader, 2020, para. 17). Design Thinking brings innovation through

the exploration of targeted, diverse, and interested perspectives. It is brainstorming at its best, coupled with rapid implementation.

Partnerships with Diverse Disciplines

As we saw, diverse perspectives can amp up creativity and innovation. This can be an internal process in which one has previous exposure to a diversity of ideas and experiences and, therefore, approaches problems from a wide and inclusive view. Diverse perspectives can also be built into the curriculum with intentional opportunities for students to actively engage with others from differing education and experiential backgrounds. Tiffany Kelley, PhD, MBA, RN stated, "The more we can get students to work together and think about how to creatively problem solve, the stronger we will be in uncertain times" (Spader, 2020. Para 10).

One prime example of how this can be done is the University of Connecticut's (UConn) Nursing program which encourages students at all levels to partner with students from other majors, such as health disciplines, engineering, and business. This fuels a collaborative process for addressing healthcare challenges with innovative solutions from multiple points of view (Spader, 2020). The University of Connecticut offers a certificate program and a master's degree in Health Innovation that employ principles and practices of Design Thinking to foster an orientation towards solving problems and utilizing resources in new, effective ways (Spader, 2020). The program encourages divergent thinking and teaches students to assess the potential benefits and risks associated with taking their ideas to implementation.

The faculty and program leadership are committed to "discovery and communication of breakthrough and foundational ideas; to translation and collaboration across disciplines and communities; and positive transformation through research, scholarship, and creative works" (University of Connecticut, 2024. para. 1) . One way this is accomplished is through the strategic collaboration between the Schools of Nursing and College of Engineering to spur the development of innovative healthcare technology. University of Connecticut's approach aligns with many of the external factors that support individual the creative process including, creating a culture of learning, promoting a safe and accepting environment for sharing creative ideas, and collaborating with others for diverse perspectives.

These innovative instructional practices and applications can spearhead a movement to engage students in activities to build creative capacity and self-confidence in their abilities to innovate. Students who are engaged in creative pursuits in environments that place a clear value on thinking beyond the status quo have the potential to become healthcare leaders who inspire and encourage collaboration and innovation in the workplace. This philosophy can empower health professionals to bring about meaningful change, whether it is enhancing individual health outcomes, or driving large-scale transformation in healthcare.

Conclusion

Creativity and innovation are central to promoting clinical excellence and strong health outcomes, advancing health initiatives, improving efficiencies, adapting to changing needs, and optimizing healing environments. One HCP in leadership shared her perspective on the value of creativity and innovation:

> Creativity and innovation allow for options for personalized treatment plans that consider the unique genetic, lifestyle, and environmental factors of each patient, making healthcare more effective and compassionate. By leveraging groundbreaking technologies like telehealth and mobile apps, we're able to reach communities with limited access to traditional healthcare facilities. This helps people get the care they need, regardless of location.
>
> Innovative solutions can reduce costs by replacing expensive, traditional models with affordable, scalable alternatives. For economically disadvantaged communities, these lower-cost options offer a lifeline, ensuring that financial limitations don't stand in the way of quality care. Ultimately, creativity and innovation in healthcare break barriers and create a more inclusive, equitable system that serves everyone. (Anonymous, personal communication, 2024, May 9).

Today, healthcare institutions expect graduates to be prepared to manage the existing and new challenges they face with creative and collaborative approaches that spur innovation and fuel advancement in health and medical practices (Gravlin et al., 2022). Increasingly, higher education recognizes the value of intentional instruction and practice in creativity and innovation. To that end, healthcare programs in higher education are called upon to create curricula to promote competencies in creativity and innovative thinking.

Higher education programs for health professionals can start with incorporating specialized training on the underlying mechanisms that contribute to creative thinking and offering practical experiences in tackling real-world challenges, first for faculty, and then for students. This can help our future health professionals and leaders to develop competencies in creativity and innovation. By including the neuroscience of creative cognition and innovative practice in problem solving, change management, and interprofessional collaboration, students can build the skills and self-confidence that are necessary to freely share their ideas with colleagues and leadership in the healthcare workplace.

These concepts and instructional practices can be readily translated into professional development for working health professionals. Doing so may not only help with patient outcomes but potentially increase job retention and satisfaction (McNulty, 2024). When HCPs and administrators in healthcare institutions learn how creativity can be nurtured, both internally and externally, we will see real transformation across the spectrum of healthcare for the optimal health and well-being of all persons served. This attitude creates cultures that value and embrace change-makers and innovators in the evolving landscape of contemporary healthcare. This is how we innovate!

References

Abadzi, H., Martelli, M., & Primativo, S. (n.d.). *Explorations of creativity: A review for educators and policy making.* World Innovation Summit for Education. wise-qatar.org/app/uploads/2019/04/wisematters-cognitive creativity.pdf

Altman, M., Huang, T. T. K., & Breland, J. Y. (2018). Design thinking in health care. *Preventing Chronic Disease*, *15*, E117. https://doi.org/10.5888/pcd15.180128

Alvarez-Huerta, P., Muela, A., & Larrea, I. (2021). Student engagement and creative confidence beliefs in higher education. *Thinking Skills and Creativity, 40*(100821). https://doi.org/10.1016/j.tsc.2021.100821

Álvarez-Huerta, P., Muela, A., & Larrea, I. (2022). Disposition toward critical thinking and creative confidence beliefs in higher education students: The mediating role of openness to diversity and challenge. *Thinking Skills and Creativity*, *43*, 101003. https://doi.org/10.1016/j.tsc.2022.101003

American Association of Colleges of Nursing. (2022, August 9). *Data spotlight: Trends in graduate nursing program areas of study.* Data Spotlight: Trends in Graduate Nursing Program Areas of Study. (aacnnursing.org)

American Association of Colleges of Nursing. (2022). *The essentials: Competencies for professional nursing education.* The Essentials: Competencies for Professional Nursing Education (aacnnursing.org)

American Nurses Association. (2023). *ANA Innovation Enterprise*. ANA Enterprise Innovation in Nursing | ANA (nursingworld.org)

Arias, J., Scott, K. W., Zaldivar, J. R., Trumbull, D. A., Sharma, B., Allen, K., & Gravenstein, N. (2021). Innovation-Oriented Medical School Curricula: Review of the Literature. *Cureus*, *13*(10), e18498. https://doi.org/10.7759/cureus.18498).

Backhouse, A., & Ogunlayi, F. (2020). Quality improvement into practice. BMJ, 368, 1-8. https://doi.org/10.1136/bmj.m865

Beaty, R. E., Cortes, R. A., Merseal, H. M., Hardiman, M. M., & Green, A. E. (2023, July 20). Brain networks supporting scientific creative thinking. *Psychology of Aesthetics, Creativity, and the Arts.* Advance online publication. https://dx.doi.org/10.1037/aca000060

Beaty, R. E., Kenett, Y. N., Christensen, A. P., Rosenberg, M. D., Benedek, M., Chen, Q., ... & Silvia, P. J. (2018). Robust prediction of individual creative ability from brain functional connectivity. *Proceedings of the National Academy of Sciences, 115*(5), 1087-1092. https://doi.org/10.1073/pnas.1713532115

Beghetto, R.A., .& Karwowski, M. (2017). Towards untangling creative self-beliefs. In M. Karwowski & J. C. Kaufman (Eds.), *The creative self: Effect of beliefs, self-efficacy, mindset, and identity* (pp. 1–394). Academic Press Inc. https://doi.org/10.1016/C2015-0-07011-3

Brewster, A. L., Lee, Y. S. H., Linnander, E. L., & Curry, L. A. (2021). Creativity in problem solving to improve complex health outcomes: Insights from hospitals seeking to improve cardiovascular care. *Learning Health Systems*, *6* (2), e10283. https://doi.org/10.1002/lrh2.10283

Brooks, B., Schaab, K., & Chapman, N. H. (2019). Integration and metacognition: Engaging metacognitive capacity building strategies to enhance interdisciplinary student learning. *Issues in Interdisciplinary Studies*, *37*(1), 23-53. NODOI

Chan, M. Y. Ralph, M. L. Robinson, G. (2023). The neurocognitive cornerstones of creative thought. PsyArXiv. https://doi.org/10.31234/osf.io/mv2q7

Chang, Y., & Shih, H. (2019). Work curiosity: A new lens for understanding employee creativity, *Human Resource Management Review, 29* (4). 100672 https://doi.org/10.1016/j.hrmr.2018.10.005.

Cofrancesco Jr, J., Wright, S. M., Vohr, E., & Ziegelstein, R. C. (2017). Creating an "Education Shark Tank" to encourage and support educational scholarship and innovation. *Academic Medicine*, *92*(11), 1578-1582.https://doi.org/10.1097/ACM.0000000000001715

Dearnley, C., McClelland, G., & Irving, D. (2013). *Innovation in teaching and learning in health: A literature review.* Council of Deans of Health. Innovation-in-Teaching-and-Learning-in-Health-HE-Lit-Review-20130926.pdf (councilofdeans.org.uk)

Dietrich, A., & Zakka, S. (2023). Education, neuroscience, and types of creativity. *Future of Educational Research, 1*. https://doi.org/10.1002/fer3.7

Frey, D. H. (1975). Anatomy of an idea: Creativity in counseling. *Personnel & Guidance Journal*, 54, 22–27.

Gravlin, G., Fortunato-Habib, M., Gemme, D., Carney, B., & Dick, K. (2022). Diving in: Using a "Shark Tank" approach to teach business skills to future DNP leaders. *Journal of Professional Nursing*, *40*, 66-72. https://doi.org/10.1016/j.profnurs.2022.03.002

Gregoire, C. (2019). *Understanding the four stages of the creative process*. WeWork Ideas. Understanding the four stages of the creative process (wework.com)

Gube, M., & Lajoie, S. (2020). Adaptive expertise and creative thinking: A synthetic review and implications for practice. *Thinking Skills and Creativity*, *35*, 100630. https://doi.org/10.1016/j.tsc.2020.100630

Harvard (2018, January 23). *The creative brain is wired differently.* NeuroscienceNews. The Creative Brain is Wired Differently - Neuroscience News

Henriksen, D., Richardson, C., & Shack, K. (2020). Mindfulness and creativity: Implications for thinking and learning. *Thinking Skills and Creativity*, *37*, 100689. https://doi.org/10.1016/j.tsc.2020.100689

Huang, T. T. K., Callahan, E. A., Haines, E. R., Hooley, C., Sorensen, D. M., Lounsbury, D. W., ... & Hovmand, P. S. (2024). Leveraging systems science and design thinking to advance implementation science: moving toward a solution-oriented paradigm. *Frontiers in Public Health*, *12*, 1368050. https://doi.org/10.3389/fpubh.2024.1368050

Jain, N. (2023, July 15). *What is innovation?* IdeaScale. https://ideascale.com/blog/what-is-innovation/

Kelly, C. J., & Young, A. J. (2017). Promoting innovation in healthcare. *Future Healthcare Journal*, *4*(2), 121–125. https://doi.org/ 10.7861/futurehosp.4-2-121

Manning, D. (2020). *Artificial Intelligence definitions.* Stanford Center for Human Centered Artificial Intelligence. AI-Definitions-HAI.pdf (stanford.edu).

Marzola, P., Melzer, T., Pavesi, E., Gil-Mohapel, J., & Brocardo, P. S. (2023). Exploring the role of neuroplasticity in development, aging, and neurodegeneration. *Brain Sciences*. *13*(12):1610. https://doi.org/10.3390/brainsci13121610

McNulty, C. (2024). *Fostering a culture of innovation: A nurse manager's call to action.* American Nurses Association Innovation. https://www.nursingworld.org/practice-policy/innovation/blog/fostering-a-culture-of-innovation-a-nurse-managers-call-to-action/

Medina, M. S., Castleberry, A. N., & Persky, A. M. (2017). Strategies for improving learner metacognition in health professional education. *American Journal of Pharmaceutical Education*, *81*(4), 78.

Menon, V. (2023). 20 years of the default mode network: A review and synthesis. *Neuron*. *11*(16), 2469-2487. https://doi.org/10.1016/j.neuron. 2023.04.023

Niranjan-Azadi, A., Moulder, G., Gusic, M. E., Hoke, G., Pahwa, A., & Parsons, A. S. (2023). A novel virtual course to teach medical students high-

value decision-making. *The Clinical Teacher*, *20*(4), e13597. https://doi.org/10.1111/tct.13597

NSW Department of Education. (2020). Metacognition: A key to unlocking learning. https://education.nsw.gov.au/content/dam/main-education/teaching-and-learning/education-for-a-changing-world/media/documents/Metacognition_Full_Report_FINAL.pdf

O'Sullivan & Dooley. (2008). *Applying innovation*. Sage Publications. http://www.nuigalway.ie/staff-sites/david_osullivan/documents/2011_ai_booklet.pdf

Reisman, F., Keiser, L., & Otti, O. (2016). Development, use and implications of diagnostic creativity assessment app, RDCA–Reisman Diagnostic Creativity Assessment. *Creativity Research Journal*, *28*(2), 177-187. https://doi.org/10.1080/10400419.2016.1162643

Sandars, J., & Goh, P. S. (2020). Design thinking in medical education: The key features and practical application. *Journal of Medical Education and Curricular Development*, *7*, 2382120520926518. https://doi.org/ 10.1177/2382120520926518

Sentilkumar, G., & Cole, K. (2022, January 17). We need to encourage and support medical student innovation. In Training. We Need to Encourage and Support Medical Student Innovation » in-Training, the online peer-reviewed publication for medical students

Spader, C. (2020, September 29). *Partnerships and innovations: The future of nursing. American Nurse.* American Nurse. Partnerships and innovation: The future of nursing education (myamericannurse.com)

Sun, J., Chen, Q., Zhang, Q., Li, Y., Li, H., Wei, D., Yang, W., & Qiu, J. (2016). Training your brain to be more creative: Brain functional and structural changes induced by divergent thinking training. *Human Brain Mapping*, *37* (10), 3375–3387. https://doi.org/10.1002/hbm.23246

Swart, T. (2019, October 11). *The neuroscience of creativity.* Stanford Social Innovation Review. https://ssir.org/books/excerpts/entry/the_neuroscience _of _creativity

Ten Haven, A., Pragt, E., Luijk, S. J. V., Dolmans, D. H., & van Mook, W. N. (2022). Creativity: A viable and valuable competency in medicine? A qualitative exploratory study. *Medical Teacher*, *44*(10), 1158-1164. https://doi.org/10.1080/0142159X.2022.2072278

University of Connecticut. (2024). *Advancing health through innovation.* Innovation & New Knowledge | School of Nursing (uconn.edu)

Uunona, G. N. & Goosen, L. (2023). Leveraging ethical standards in artificial intelligence technologies: A guideline for responsible teaching and learning applications. In M. Garcia, M. Lopez Cabrera, & R. de Almeida (Eds.), *Handbook of research on instructional technologies in health education and allied disciplines* (pp. 310-330). IGI Global. https://doi.org/10.4018/978-1-6684-7164-7.ch014

Vartanian, O., Saint, S. A., Herz, N., & Suedfeld, P. (2020). The creative brain under stress: Considerations for performance in extreme environments. *Frontiers in Psychology*, *11*, 585969. https://doi.org/10.3389/fpsyg.2020.585969

Weiland, B., de Wit, J, & deRooji, A. (2022). Electronic brainstorming with a Chatbot partner: A good idea due to increased productivity and idea diversity. *Frontiers in Artificial Intelligence, 5*. 1-10. https://doi.org/10.3389/frai.2022.880673

World Health Organization. (2024). *Health innovation for impact.* Health innovation for impact (who.int)

Wong, C. (2019). Changing organizational culture: From embedded bias to equity & inclusion. *Professional Safety*, *64*(08), 26-30. F1_0819.pdf (assp.org)

Zhang, J., Gong, Z., Zhang, S., & Zhao, Y. (2017). Impact of the supervisor feedback environment on creative performance: a moderated mediation model. *Frontiers in Psychology*, *8*, 237148. https://doi.org/10.3389/fpsyg.2017.00256